Micromass PC
Instruction manual

MP MASTER
MA25308

VG QUADRUPOLES

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Glenn 654-9327

MICROMASS PC

MANUAL

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CONTENTS

1.	IMPORTANT INFORMATION	5
2.	QUICK GUIDE TO OPERATION	6
3.	INTRODUCTION	7
3.1	Notation Conventions	7
4.	INSTALLATION	8
4.1	Checks on receipt of the instrument	8
4.2.	Analyser Head Installation	8
4.3.	Remote Head Installation	9
4.4.	Control Unit Installation	9
4.5.	Instrument Fusing And Power	10
5.	OPERATION FROM KEY PAD	11
5.1.	Function Boxes	11
5.2.	The Screen Editor	
5.3.	Key Mapping	
5.4.	Entering Filenames	11
5.4.1	Screen Entry	12
5.4.2	Filename Conventions	12
5.5.	The String Editor	12
6.0	SOFTWARE DESCRIPTION	14
6.1.	Initial Program Load	14
6.2.	Setup Menu	15
6.2.1	Command Page	15
6.2.2	Setup Communications	
6.2.3	Enter Remote Control	19
6.3.	Analogue Scan	19
6.4.	Histogram Scan	21
6.4.1	Align / Calibrate Mass Scale	22
6.4.2	Linear Histogram	23
6.4.3	Logarithmic Histogram Display	26
6.4.4	Library Mode	26
6.4.4.1	Visual Compare Scan With Library	27
6.4.4.2	Automatic Library Search	28
6.4.4.3	List / Edit Reference Data	28
6.4.4.4	Store Current Spectrum In Library	31
6.5.	Multiple Ion Monitoring	31
6.5.1	Edit Recipe	33

6.5.2	Run	37
6.5.2.1	Table Mode	38
6.5.2.2	Trend	40
6.5.3	Read Recipe	42
6.5.4	Background Menu	43
6.5.4.1	Acquire Backgrounds	44
6.5.4.2	Clear Backgrounds	44
6.5.5	Alarms	44
6.6.	Data Disk Management	45
6.6.1	Review Stored Data	45
6.6.2	Display Directory Of Data Files	47
6.6.3	Format A New Data Disk	47
6.6.4	Making A Copy Of A Diskette	47
6.7.	Leak Detection	48
7.	INSTRUMENT FUNCTIONS	50
7.1.	Principles Of Operation	50
7.2.	Front Panel Controls	50
7.3.	Rear Panel	51
7.3.1	Analogue Input/Output Connections	51
7.3.2	MP8X Multiplexer Control	51
7.3.3	Valve Driver	51
7.3.4	Auxiliary Input/Outputs	52
7.3.5	Alarms	52
7.3.6	Slot Card Connections	52
7.3.7	Cooling Fan	53
7.3.8	Voltage	54
7.3.9	Power Input	54
7.3.10	Fuses	55
7.4	Colour display	55
7.5	Key Pad	55
7.6.	Motherboard	56
8	ANALYSER HEAD MAINTENANCE	57
8.1.	Replacing the Filament Assembly	57
8.2.	Non-Standard Filament Materials	58
8.3.	Cleaning The Analyser Head	59
9.	INSTRUMENT ADJUSTMENT	60
9.1.	Control Unit	60
9.1.1	Current Limit	60
9.1.2	Ion Energy	60

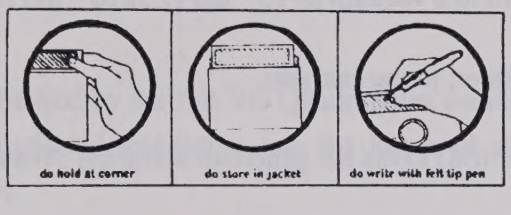
9.1.3	RF Voltage	60
9.2.	RF Generator	60
9.3.	Re-tuning	61
9.3.1	Check Current Limit	61
9.3.2	Check RF Voltage	61
9.3.3	Check DC Voltage	61
9.3.4	Amplifier Zero	61
9.3.5	Resolution and ΔM	61
9.3.6	Mass Scale Alignment	61
9.4.	Fault Finding Guide	62
10.	OPTIONS	67
10.1.	Parallel printer	67
10.2.	Serial Printer	68
10.3.	Analogue Outputs	68
10.4	Plotter	68
11.	OFF-LINE DATA REVIEW	70
12.	RF GENERATOR - 100 amu Units	71
12.1	Amplifier	72
12.2	SEM Supply (D)	73
12.3	RF Generator 200 and 300 amu Units	74
12.4	Operation	74
12.5	Digitally controlled head amplifer	76
12.6	PCB1 Current Amplifier	76
12.7	PCB2 Voltage Amplifier	76
12.8	Power Supply for the Secondary Emission Multiplier (SEM)	79
12.9	Pole Bias Option	80
13.	APPENDIX A - GLOSSARY OF VACUUM TECHNOLOGY	82
14.	APPENDIX B - MICROMASS PC SPECIFICATION	86
15.	APPENDIX C - GENERAL PRINCIPLES OF OPERATION	90
16.	APPENDIX D - RELATIVE SENSITIVITY FACTORS FOR 5" FILTER QUADRUPOLE ANALYSERS	92

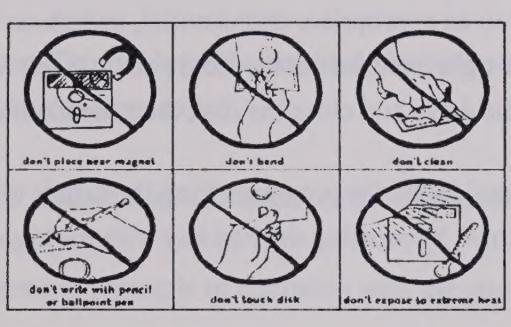
16.	APPENDIX D - RELATIVE SENSITIVITY FACTORS FOR 5" FILTER QUADRUPOLE ANALYSERS	92
17.	APPENDIX E - AUTOMATIC LIBRARY SEARCH	96
18.	APPENDIX F - REMOTE OPERATION	98
19.	WARRANTY	130

1. IMPORTANT INFORMATION

To avoid damage to the heads in the drive, the protective card supplied must be in the disk drive whenever the instrument is moved.

The normal recommendations apply to handling both system and data disks as follows:





Do not switch the unit off then immediately on: some sensitive electronics in the unit may be affected by this dual surge action. A delay of six seconds should prevent any possible damage.

WARNING

This mass spectrometer equipment produces high voltages and should be operated and maintained strictly in accordance with its manual.

Servicing should only be undertaken by authorised personnel.

If in doubt contact your local VG Representative.

2. QUICK GUIDE TO OPERATION

i. Unpack the instrument and check contents against shipping list. Check for possible transit damage.

ii. Carefully insert the analyser into a vacuum system with a new gasket and bolt it up. Pump the system down to a vacuum of 10^{-4} mb (7.5×10^{-5} torr) or better.

iii. Connect the RF generator; to the analyser.

iv. Connect the controller (S8) to the RF generator using the 37-way cable supplied.

v. Plug in the controller to an appropriate mains outlet, switch on the controller using the "Power" switch on the right hand side of the front panel. Insert a copy of the Micromass PC system disk into the drive and close the disk door handle if necessary.

vi. When the controller has loaded the programs from the disk it will present a "Command Page". Enable ***EMISSION*** by pressing the **Ent** key with the highlight over the Emission box.

vii Pressing **Esc** will return to the main Menu, and selecting option 3 (Histogram Display), sub option 2 presents a linear Histogram scan of gas species in the system.

Most functions have an associated help command, activated by the **?** key.

3. INTRODUCTION

The MICROMASS PC, is a simple to operate Residual Gas Analyser (RGA) controlled from an IBM® PC style motherboard; and associated dedicated hardware. The controller comprises an integral colour display and disk drive and is operated from a front panel key pad. The unit is capable of both total pressure and partial pressure measurement, and offers a leak detect mode amongst its extensive facilities.

The MICROMASS PC is backed by the full VG Quadrupoles warranty and service organisation, and brings the latest sophisticated techniques into the hands of all vacuum users in a readily understood and usable form.

Study the Glossary of Vacuum Terminology (Appendix A) before reading this manual if unfamiliar with vacuum and simple mass spectrometry.

Appendix B contains the full technical specification for the instrument.

Appendix C describes the general principle of operation with the quadrupole analyser.

Appendix D extends information on Sensitivity details.

Appendix E describes the principles of operation behind the Automatic Library Search routines.

Appendix F is a complete description for the Remote Operation Mode.

3.1. Notation Conventions

- Keyboard; input is shown in **bold** type; eg. **Ent**
- Text that is displayed on the screen is shown in **constant width type**; eg ***COMMAND PAGE***

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4. INSTALLATION

4.1. Checks on receipt of the instrument

On receipt of the Micromass PC, remove all packing material and check immediately that all items on the shipping list have been recieved, and that no visible damage has been caused to the package or equipment.

If any damage or omissions are found contact the company or your local agent immediately.

The packaging for the Micromass PC is designed to provide all the protection normally required, should any damage have occurred to the box, then retain it for our inspection to aid future despatch quality.

4.2. Analyser Head Installation

The analyser head for the Micromass PC is contained inside a plastic envelope. Carefully remove the packing material from the analyser.

Connect the analyser to your vacuum system via a 70mm Conflat flange using a new copper gasket. Take care to cross tighten bolts to achieve an effective seal. Supplies of gaskets and stainless steel nuts, bolts and washers may be obtained from VG Quadrupoles.

If the system has a vacuum port flange other than the Conflat type, then VG Quadrupoles can provide a special adaptor to interface between the system and the Micromass PC analyser.

CAUTION: Great care must be taken not to damage the ceramic insulators whilst inserting the head.

The source is of the electron impact type and electrons are generated by a hot wire filament. Thus the performance of the analyser is affected by the ingress of electrons from any other electron generator in the system.

Once the analyser is installed, prepare the vacuum system in the usual way.

The maximum recommended baking temperature for the head is 300°C. Repeated baking at temperatures above this may cause vacuum leaks to occur on the feedthrough assembly.

4.3. Remote Head Installation

The remote head; for the Micromass PC contains both the RF generator, to provide power to the analyser head, and an amplifier to detect and amplify the ion current arriving at the collector.

The remote head must be guided carefully onto the analyser feedthroughs. The locating slot must align to achieve the correct orientation.

On the 200D and 300D units, the RF generator is connected to the analyser via an integral connecting lead. On the more sensitive gain ranges, the current flowing down this cable from the detector can be as small as $1x10^{-13}$ Amps. If the cable is knocked or subject to vibration spurious signals are produced which swamp the detector current, causing noisy output. This effect is common to quadrupole RGAs and is called *microphony*; it is due to small emfs generated when the cables are disturbed. It can be minimised by not touching the cables and arranging their path so they can be fastened to a solid fixture.

4.4. Control Unit Installation

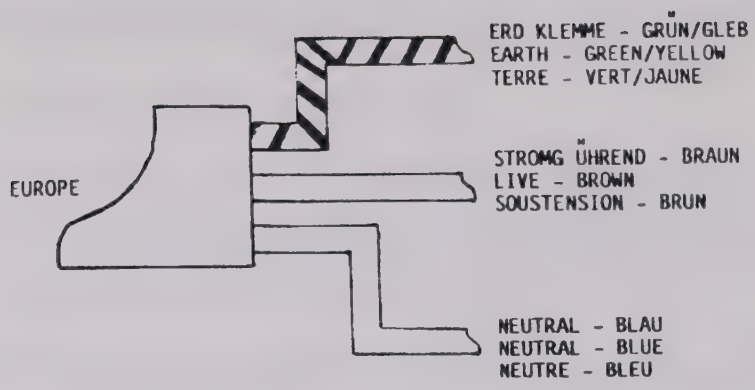
The Micromass PC is suitable for free-standing on a bench, or for mounting in a 19" rack. When used on a bench surface, the controller is fitted with tilting front feet to angle the front panel towards the user, providing a better viewing angle.

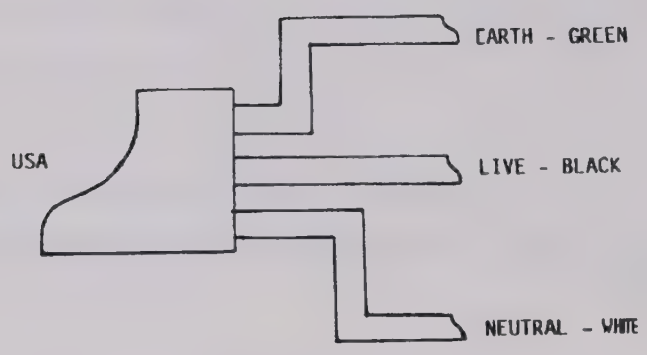
When rack mounted a 1U air gap **must** be present above and below the controller to provide adequate ventilation. The tilt feet are easily removed by unscrewing the screws passing through each foot.

To remove the top cover remove the screws on the instrument sides; the top panel then lifts off.

WARNING: WITH THE LID REMOVED DANGEROUS VOLTAGES MAY BE PRESENT ON THE BOARDS.

A mains power lead is supplied with the unit, and requires a suitable mains connector. The colour coding of the lead is to the International Standard Coding, or the US colour codes (as overleaf).





The 37-way multicore cable must be connected between the rear of the controller and the RF generator. The cable is normally 2m, though other lengths up to 100m are available on request from VG Quadrupoles, these cables are fitted with screw lock connections at each end for secure connections.

4.5. Instrument Fusing And Power

The instrument is equipped with a 3A anti-surge.fuse; in the live line. The power switch is of a double pole type, switching both the live and neutral. The power consumption is 250 VA maximum.

5. OPERATION FROM KEY PAD

5.1. Function Boxes

- Use the ← and → keys to move between function boxes
- To re-scale a parameter in a box use the ↑ and ↓ keys
- To action a changed parameter or enable a function press **Ent**
- For on-screen help at any time use **?**
- To abort the current mode and return to a higher level Menu use the **Esc** key
- The function boxes are indexed, with the leftmost box corresponding to function 1. For example, pressing the number **4** key will select to the fourth box, however, pressing the **0** key will always select the rightmost box.
- The keys are colour coded, such that the ← and → keys control the movement of the blue function-box highlight, and the parameter inside the box can be varied by use of the ↑ and ↓ keys. To activate a change in a box use the blue **Ent** key.
- On a menu page, the possible options are in green, and require a numeric entry from the green number keys to select an option.
- The other three keys are in red, and can be used at any time:

  Esc key which enables the user to quit the current operation

  ? key for help at almost every stage

  Prt key to get a hard copy of the screen display at any stage (if the printer option installed).

5.2. Entering Filenames

5.2.1 Screen Entry

The filename can be up to 8 alphanumeric characters. Do not include spaces or punctuation marks. To enter the text input utility use the **?** key; to leave the utility use **Esc**. Whilst in the text input mode, use the ← and → keys to move along the alphabet; use **Ent** to transfer the character into the file name box. To go from an upper case character to lowercase use the ↓ key. To go from a lower case character to an upper case character use the ↑ key .

5.2.2 Filename Conventions

Each file on a disk has a unique identity. The identity has two parts: a filename and an extension. A filename can be from one to eight characters in length and can be typed in upper case (CAPITALS) or lower case letters. The system automatically converts filenames to upper case letters.

Filename extensions consist of a period followed by one, two or three characters. The extensions are chosen by the system to describe the contents of a file. For instance, Histogram files are saved with a file extension of ***.HST***. The following filename extensions are allocated to files by the system:

.ANL	Analogue Scan Data File
.CMA	CMA Energy Scan Data File
.HST	Histogram Scan Data File
.LGH	Log Histogram Scan Data File
.PS	MIM Cycle Data File
.XPS	MIM Cycle (MP-8X) Data File
.RCP	MIM Recipe File
.PRO	MP8X Profile File

When entering an identity do not enter the filename extension.

The following characters are not valid within filenames: / \ [ ] . < > : * " |

If in doubt use only letters and numbers.

5.3. Text Entry

- For simplicity of operation, the number of keys is kept to a minimum. There is, however, a requirement to enter text either as a file name, gas species name or chemical formula. This is still possible on the Micromass PC. When prompted for text entry, press the **?** key The alphabet and other special characters are then displayed at the bottom of the screen. By pressing the ← and → keys, the text highlight moves accordingly and the character at the text highlight appears in the text entry box on the upper section of the monitor; to select the character key **Ent**. To change from upper case to lower case characters use the ↓ key, and to change from lower case to upper case characters use the ↑ key.

- If a mistake is made, to move backwards through the text to make a correction, place the highlight on the left ← key and use **Ent** as required. To step forward through text use the **Ent** key.

- The text highlight also wraps around, ie it is cyclic, so going clockwise after 'Z', 'a' is the next character to be selected.

- The special character '.' (period) cannot be selected by the user, this is used by the instrument as part of its operating system.

6. SOFTWARE DESCRIPTION

This chapter describes in detail each of the software operating modes available from the MICROMASS PC. Operation is designed to be simple; use this chapter for reference and be guided through the software by the screen prompts. If in doubt as to which key activates a function, press ? for a helpful message; to clear the message and restore the screen, press any key.

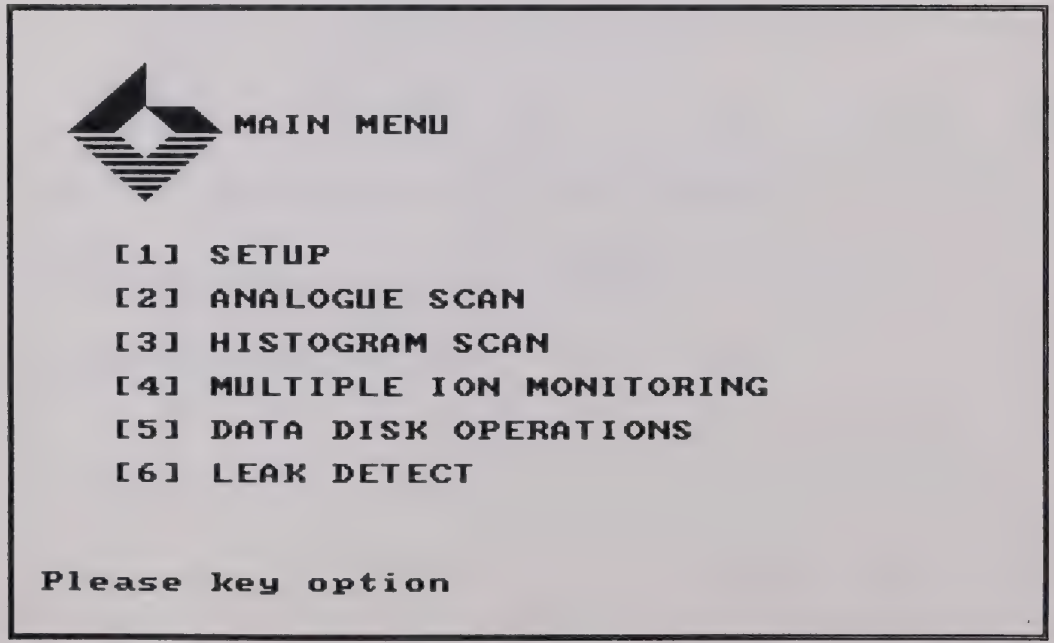
6.1. Initial Program Load

On powering up the MICROMASS PC, the instrument will load its operating system from disk, then prompts the user to enter the current time and date as described on the screen.

The values entered are transferred to the real time clock on the processor board. The time is displayed on the screen and used to time and date stamp files.

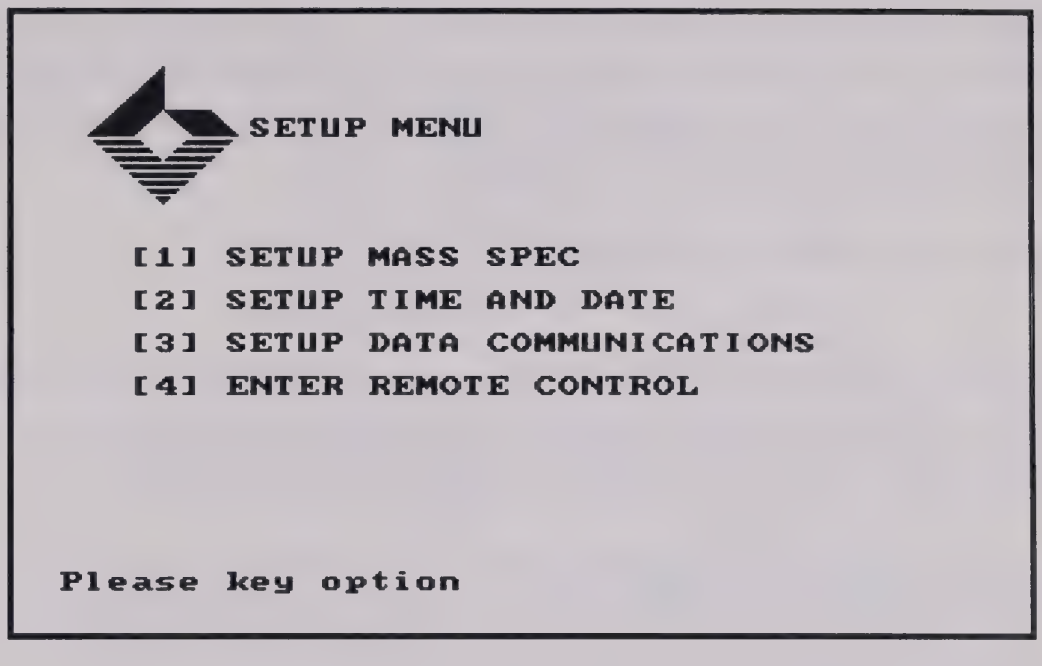
Once these parameters are set, the main MICROMASS PC program will be loaded. Whilst this is taking place the VG logo is displayed.

When the software is fully loaded menu option 1, the ***COMMAND PAGE***, is displayed automatically. Pressing **Esc** leads to the main menu:



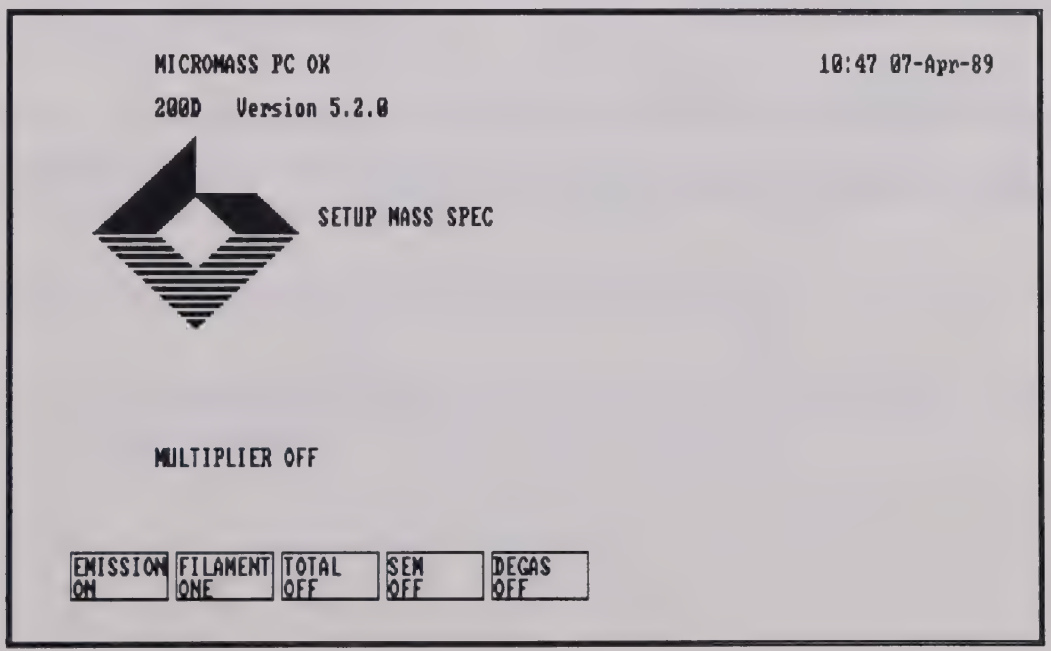
6.2. Setup Menu

Selecting option 1 from the main menu leads to the Setup Menu:



6.2.1 Command Page

Selecting option 1 from the Setup Menu leads to the Command Page:



EMISSION is shown as the active function. Press **Ent** to turn emission on and off.

When ***EMISSION ON*** is selected the message at the top of the screen should show **MICROMASS PC OK**, which confirms that all the status lines show normal operation. The data system continuously monitors the status of emission, filament, RF and pressure trip lines and displays an appropriate message if a fault condition arises. For example, turning emission ***OFF*** produces the message **EMISSION OFF** at the top of the screen.

Use the function boxes to change parameters:

1 EMISSION

Press **Ent** to switch emission ***ON*** or ***OFF***. When switching emission ***ON***, a **WAIT** message is displayed in the box until status is stabilised. If emission cannot be switched on due to a fault condition an error message will be printed accordingly at the top of the screen.

2 FILAMENT

Press **Ent** to toggle between filament 1 and 2.

3 TOTAL

Press **Ent** to toggle ***TOTAL PRESSURE*** read-out ***ON*** and ***OFF***.

4 SEM

Press **Ent** to toggle the multiplier ***ON*** or ***OFF*** (SEM - Secondary Electron Multiplier). When turning the multiplier on the screen clears to display:

measuring total pressure - please wait

which is followed by the multiplier selection menu overleaf:

```
          SEM CALIBRATION EDIT PAGE

Total Pressure =  9.99F-6

                    WARNING - PRESSURE HIGH !
                    cannot calibrate at this pressure

                  multiplier on [Yes/No]:  No          0:No
                                                       1:Yes
                  volts [600-3500]:  799

                  calibration mass (0 for total):  0

                  calibrate [Yes/No]:   No             0:No
                                                       1:Yes


Enter data in screen format:  key * to accept data and exit: key Esc to abort
```

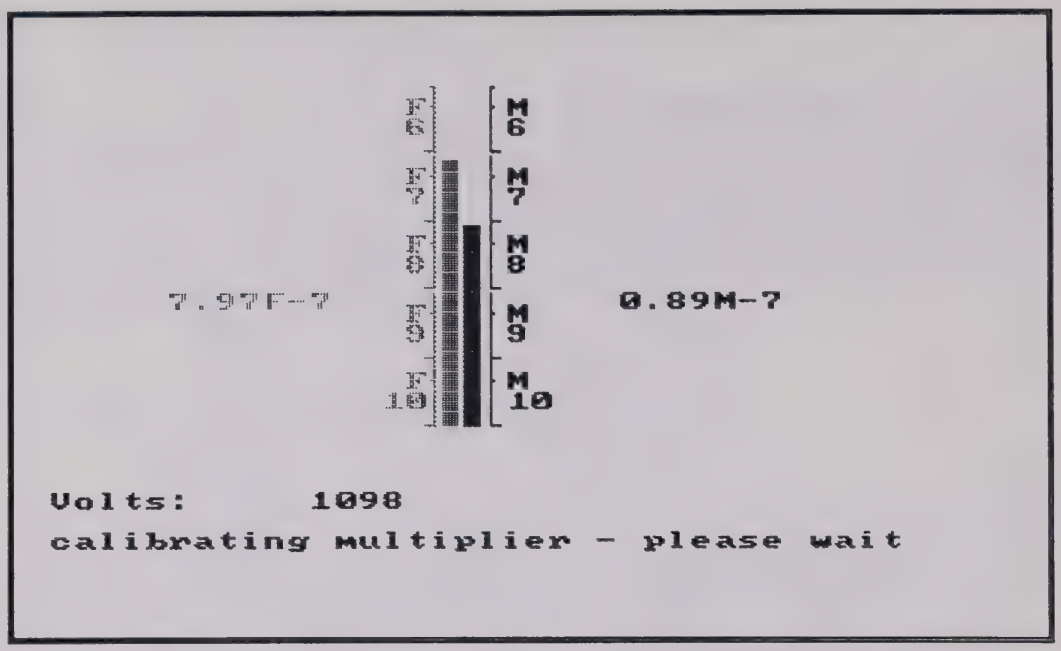
If the measured pressure is below 9 x 10^{-7} mbar, the **multiplier on** field is automatically set to **Yes**. At higher pressures, manually enter **Yes** to turn on the multiplier, but operation at high pressure is not recommended. As a guideline, the highest current drawn from the multiplier must be limited to 1μa.

To calibrate the multiplier against the Faraday detector enter **Yes** next to the **calibrate [Yes/No]** field. To operate the multiplier at a particular voltage, enter **No** after calibrate, and enter the desired voltage after the **volts [800-3500]** field.

The SEM can be calibrated against the Faraday detector in either total or partial pressure mode. To select total pressure enter a value of **0** in the mass box; otherwise enter a mass number on which the SEM will calibrate in partial pressure mode.

When finished, key * to execute the options, or *ESC* to abort the mode.

If calibration is not requested, the screen returns to the *COMMAND PAGE*. Otherwise a calibration sequence is initiated as overleaf:



The instrument measures total or partial pressure using the Faraday detector and then display it as a bar graph in purple. It then increases/decreases the multiplier voltage from the preset value until the same signal reading is obtained.

The instrument is now calibrated and the screen automatically returns to ***COMMAND PAGE***. The actual voltage set on the SEM is displayed.

If the SEM did not self-calibrate but was enabled at a user defined value, the SEM voltage can still be altered manually. With the SEM on, enable TOTAL pressure by pressing **Ent** over the corresponding base line box, and use the ↑ and ↓ keys to alter the SEM voltage in steps of 15V and thus alter the total pressure reading displayed.

The advantage of this is that when the total pressure is too low to be read by the Faraday detector, an external gauge can be used to manually calibrate the SEM.

5 DEGAS

Degas is a procedure for 'cleaning' the source region of the quadrupole analyser by high energy electron bombardment (500eV). It is used when source contamination is suspected or after a system bakeout to outgas the analyser source area.

To enable Degas, press **Ent** in the Degas box. A graph is drawn on the screen showing the profile of the degas power ramp against time. As Degas proceeds a thick red line is drawn over the profile line showing the current status of Degas. Pressing **Ent** or **Esc** aborts Degas.

If the SEM is on Degas cannot be used (a screen message to this effect is displayed). Turn the SEM off before any further attempt to use Degas. Likewise, Degas cannot be used if the emission is off. A screen message to this effect is displayed. Turn on the emission before attempting to use Degas.

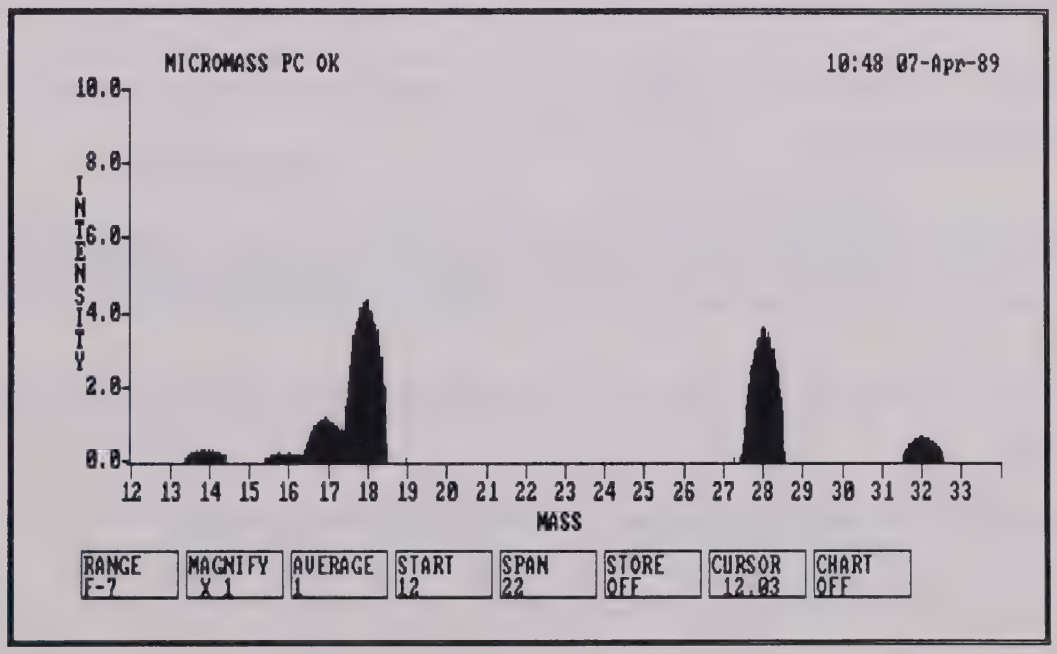
To exit from the Command Page key **Esc.** This returns the screen to the setup menu.

6.2.3 Enter Remote Control

Selecting this option initiates Remote Control. This is described in detail in Appendix F.

6.3. Analogue Scan

This mode enables the true peak shape and resolution to be viewed throughout the entire mass range. When option 2 is selected from the main menu, an analogue scan is displayed:



Use the function boxes to change parameters:

1 RANGE

The amplifier gain is increased or decreased using the ↑ and ↓ keys.

The detector currently in use is indicated by the letters **M** or **F**, Multiplier or Faraday respectively. Measurements cannot be made with the Faraday detector if the SEM is turned on (in the Command Page).

The available gain ranges are as follows: Faraday (F): 10^{-5} to 10^{-10}, Multiplier (M): 10^{-7} to 10^{-13}.

Partial pressures are indicated by the peak heights on the display.

2 MAGNIFY

The display can be magnified by up to a factor of 10 in the y direction. This is achieved by changing the integer value in the magnify box using the ↑ and ↓ keys. Press **Ent** to implement the re-scaling of the y-axis.

3 AVERAGE

Some signal averaging is performed at the time of measurement to give the best compromise between speed of data collection and signal-to-noise ratio. The ***AVERAGE*** function allows the user to increase this averaging.

Use the ↑ and ↓ keys to set the desired number of standard measurements to be averaged (powers of two), then press **Ent**.

4 START

This function controls the start of the mass window, the value of which is shown numerically in the box and graphically by a yellow cursor line immediately beneath the spectrum.

The location of the start of the window along the mass axis can be set as desired by using the ↑ and ↓ keys.

Once the desired start mass is indicated, press **Ent** to implement the change.

5 SPAN

This function controls the span (width) of the mass window, the value of which is shown numerically in the box and graphically by a yellow cursor line, immediately beneath the spectrum.
The mass span can be set as desired by using the ↑ and ↓ keys.

Once the desired mass span is indicated, press **Ent** to implement the change.

NOTE: **If either the start or span is changed without pressing Ent, the other parameter can also be changed. Pressing Ent after that implements the changes made to both parameters.**

6 STORE

This function allows Analogue Scans to be stored to disk for subsequent analysis.

Press **Ent** and the screen clears to request a file name. Key * after entering the file name to return to Analogue Scan and start data storage.

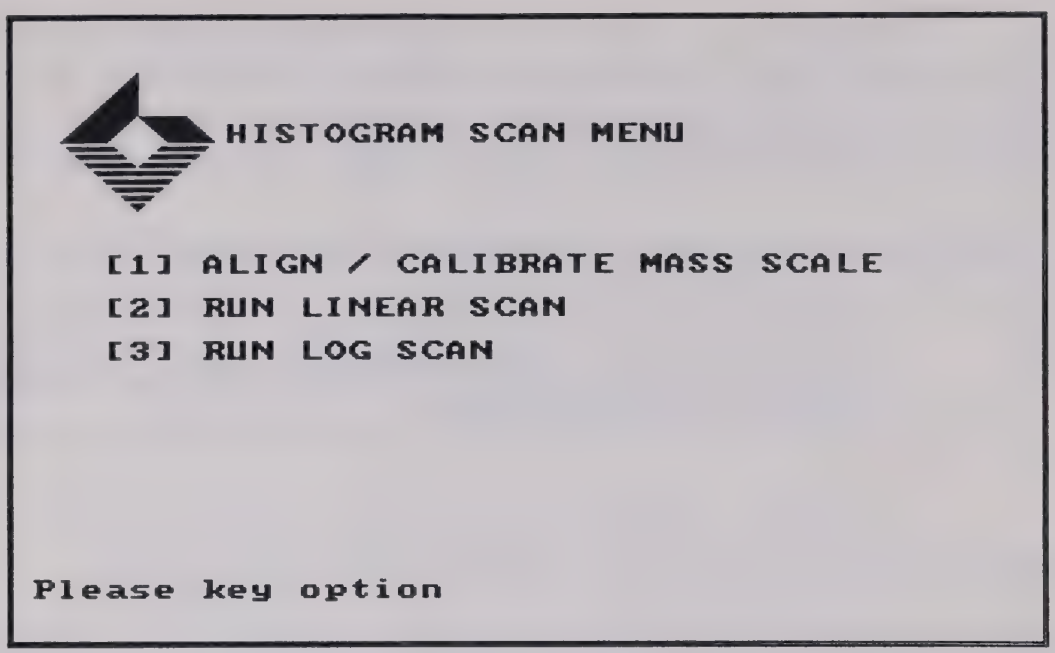
Each scan is stored to disk until the ***STORE*** function is turned off by pressing **Ent** again.

7 CURSOR

This function allows peak positions to be identified. Use the ↑ and ↓ keys to alter the cursor position. The new position of the cursor is only updated on each cycle to prevent slow data gathering. The current cursor position is shown in purple, overlaid on the spectrum.

6.4. Histogram Scan

From the ***MAIN MENU***, option 3 is the Histogram mode. This has a sub-menu for the three options available from within this mode (as overleaf):



Histogram mode is where a single measurement is taken at each mass. The reading is taken at a position where the peak top is assumed to be, with the peak height being related to the partial pressure.

If only partial pressure for each mass is required, then this mode has a much faster data acquisition than analogue scan, since only one reading per mass is taken.

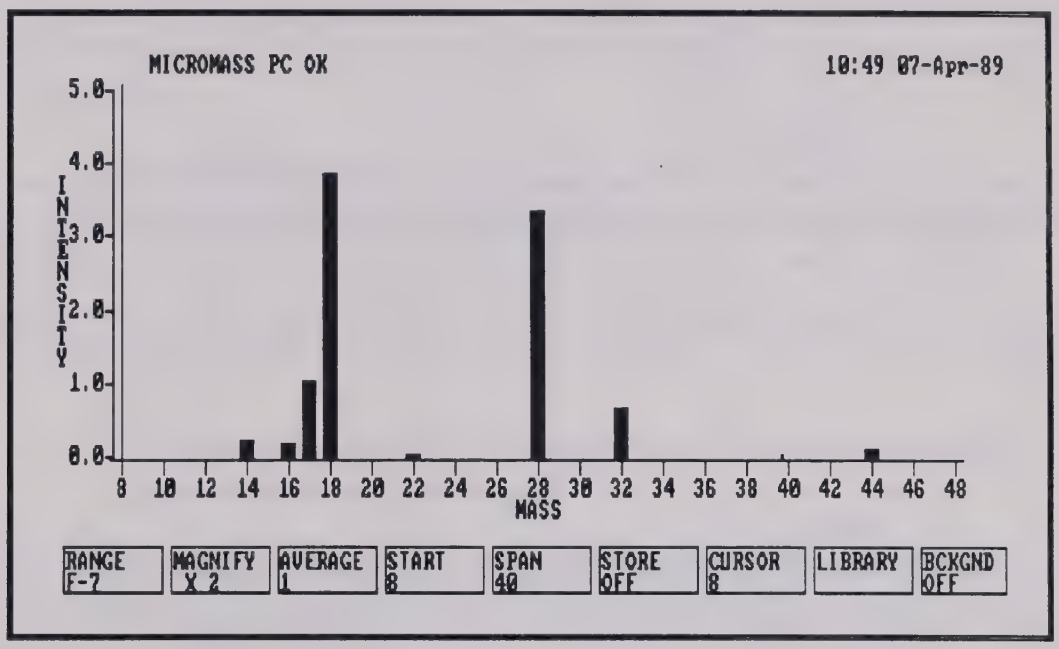
6.4.1 Align / Calibrate Mass Scale

If significant drift in the electronics occurs (possibly due to large temperature fluctuations) the single reading at each mass might not be taken at the peak top but on the peak shoulder, causing a false reading. Option 1 allows setting of the instrument scanning over a given gain and mass range. The instrument then locks onto the peak top for each mass found and interpolates the mass scale for all other masses.

If a mass scale alignment has already been performed, alignments can be initiated from the current positions, otherwise the routine uses ideal positions. To leave the edit page, key *. The screen clears to display a real time peak-locking page showing the current status of the parameters. When the alignment is completed (the time taken is dependant on the mass range and pressure ranges chosen) the program returns to the Histogram menu.

6.4.2 Linear Histogram

The second option, linear histogram scan, sets the amplifier on a single but variable fixed-gain range. If this is the first measurement mode selected when the instrument is powered-up, the full mass range scan is displayed, but otherwise the scan window is 'inherited' from a previous analogue or linear histogram scan. The screen display below shows a typical linear histogram scan:



Use the function boxes to change parameters:

1 RANGE

The amplifier gain is increased or decreased using the ↑ and ↓ keys.

The detector currently in use is indicated by the letters **M** or **F**, Multiplier or Faraday respectively. Measurements cannot be made with the Faraday detector if the SEM is on (in the *COMMAND PAGE*).

The available gain ranges are as follows: Faraday (F): 10^{-5} to 10^{-10} Multiplier (M): 10^{-7} to 10^{-13}. Partial pressures are indicated by the peak heights on the display.

2 MAGNIFY

The display can be magnified by up to a factor of 10 in the y direction. This is achieved by changing the integer value in the magnify box using the ↑ and ↓ keys. Press **Ent** to implement the re-scaling of the y-axis.

3 AVERAGE

Some signal averaging is performed at the time of measurement to give the best compromise between speed of data collection and signal-to-noise ratio. The ***AVERAGE*** function allows the user to increase this averaging.

Use the ↑ and ↓ keys to set the desired number of standard measurements to be averaged (powers of two), then press **Ent**.

4 START

This function controls the start of the mass window, the value of which is shown numerically in the box and graphically by a yellow cursor line immediately beneath the spectrum.

The location of the start of the window along the mass axis can be set as desired by using the ↑ and ↑ keys.

Once the desired start mass is indicated, press **Ent** to implement the change.

5 SPAN

This function controls the span (width) of the mass window, the value of which is shown numerically in the box and graphically by a yellow cursor line, immediately beneath the spectrum.

The mass span can be set as desired by using the ↑ and ↓ keys.

Once the desired mass span is indicated, press **Ent** to implement the change.

NOTE: **If either the start or span is changed without pressing Ent, the other parameter can also be changed. Pressing Ent after that will implement the changes made to both parameters.**

6 STORE

This function allows Histogram scans to be stored to disk for future analysis.

Press **Ent** and the screen clears to request a file name. Key * after entering the filename to return to Analogue Scan and start data storage.

Each scan is stored to disk until the ***STORE*** function is turned off by pressing **Ent** again.

7 CURSOR

This function allows peak positions to be identified. Use the ↑ and ↓ keys to alter the cursor position. The new position of the cursor is only updated on each cycle to prevent slow data gathering. The current cursor position is shown in purple, overlaid on the spectrum.

8 LIBRARY

When **Ent** is pressed the instrument prepares to enter the Library mode. The current scan is finished (to get a complete set of up-to-date readings) and then measurements are suspended before going into Library mode.

9 BACKGROUND

Background mode takes the average of a number of readings at each mass, and then subtracts these readings from all subsequent corresponding pressure readings at the mass they were taken.

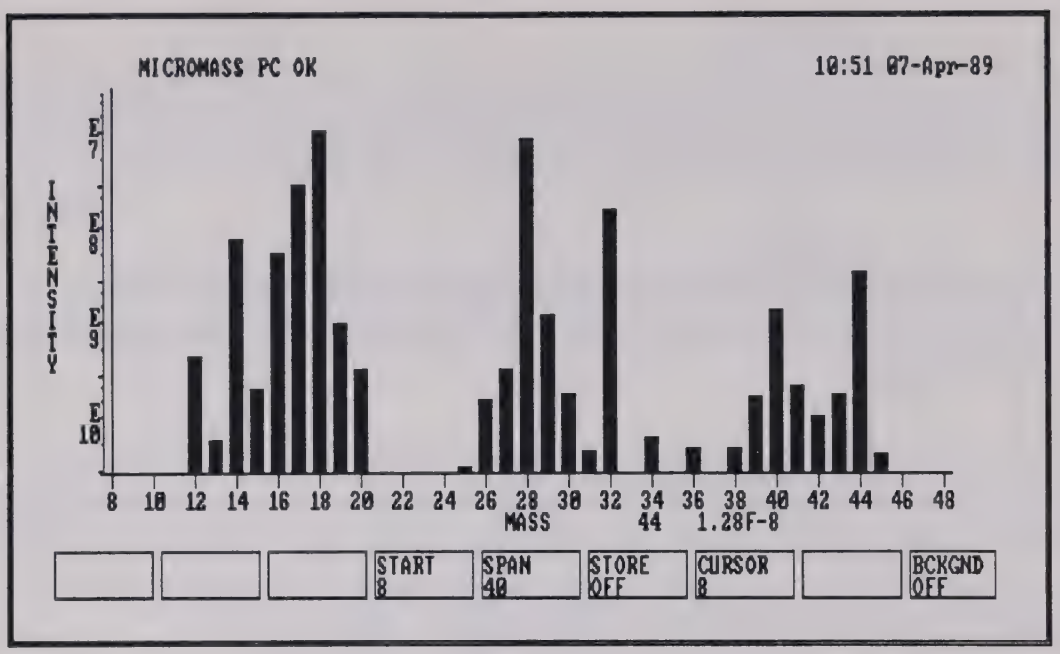
The first scan after enabling can be expected to show no peaks.

6.4.3 Logarithmic Histogram Display

Choosing option 3 from Histogram sub menu takes the user into the ***LOG HISTOGRAM PARAMETERS EDIT PAGE***, where the user sets the decades to be scanned over and the start and end masses for use. The option to store data is also offered at this stage. Once the screen is completed and * pressed, the display changes to draw the conventional mass scale, but with a log pressure axis.

The Micromass PC then carries out a single sweep to auto gain-range for the masses selected by the user before drawing in the bars relating to the pressures. The progress of this initial sweep is seen in the digital readout in the top right hand corner of the screen.

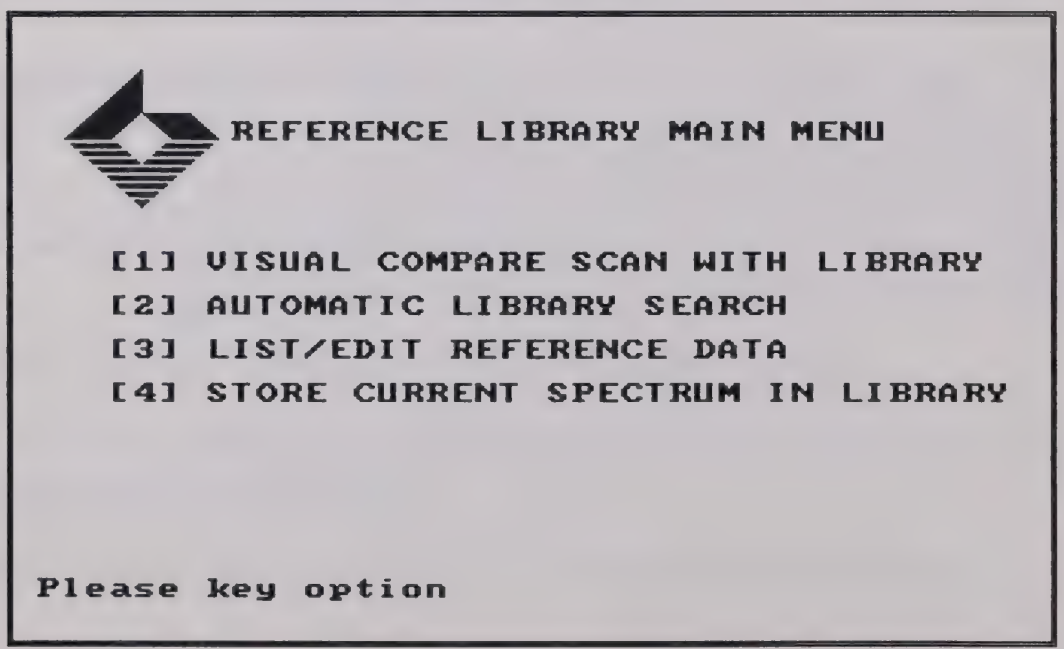
The ***AVERAGE*** box is no longer available to the user since the program decides how long to spend reading each peak depending on the gain range it has selected for that mass.



6.4.4 Library Mode

Library mode is entered from Histogram mode, and carries forward a real spectrum for analysis. The Library mode also has a sub menu to guide the user through its extensive options.

The library data base is down-loaded from disk and the message **'accessing data file'** is flashed on the screen. This leads to the Reference Library Main Menu:


REFERENCE LIBRARY MAIN MENU
[1] VISUAL COMPARE SCAN WITH LIBRARY
[2] AUTOMATIC LIBRARY SEARCH
[3] LIST/EDIT REFERENCE DATA
[4] STORE CURRENT SPECTRUM IN LIBRARY
Please key option

6.4.4.1. Visual Compare Scan With Library

The library file is a sequential file containing up to 200 cracking patterns. In this mode a single entry can be compared against the real spectrum brought from Histogram mode. A library entry number is requested; entering the value **1** displays the start of the library.

The reference number for each cracking pattern can be found from option 2.

Key **Ent** to display the data and selected reference file in a split screen format.

The reference data is shown in yellow in the top half of the screen, with the file name above the plot. The data is shown in the bottom half, plotted in green.

1 GAIN - not accessible, only shown for reference.
2 MASS
3 MAGNIFY
4 START
5 DISPLAY

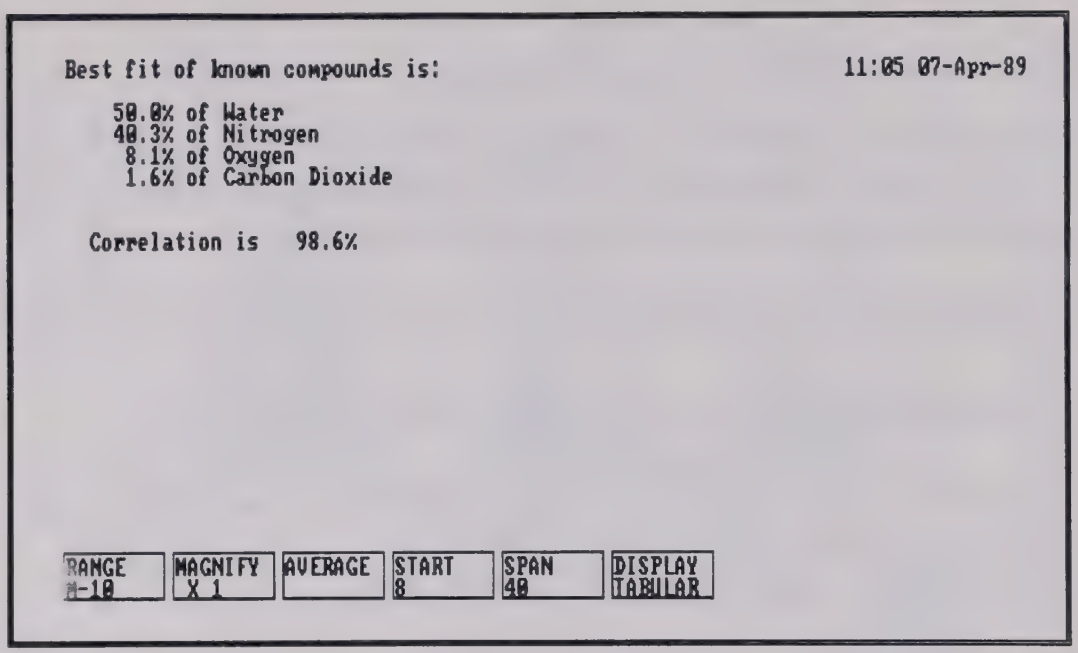
Use the ↑ and ↓ keys in this box to select between the various display modes; key **Ent** to activate that mode.

The major peaks of the reference and data are normalised to 100% and differences are highlighted by the different plotting colours. Data is laid down first in red, and then overwritten by the reference in green. Hence the major peak is always shown in green, but indicates that both data and reference are equivalent at this mass.

6.4.4.2. Automatic Library Search

The user can search the whole library, or a sub-group of the library. If a sub-group of, say, 12 species is used, then the search time is shorter than for the entire library. Each entry in the library can be assigned a 'Group ID'; for example all hydro-carbons in one group, inert gases in another group etc. Up to 99 groups in a single library are permitted.

When the option is selected, the message **started** searching followed by a series of dots is displayed to show the Micromass PC is progressing through its calculations. When the results are calculated, they are displayed in tabular mode as percentages.



6.4.4.3. List / Edit Reference Data

Selecting option 3 from the Reference Library Main Menu leads to the first page of the library data base, which lists 20 cracking patterns:

From left to right the columns are:

REF NO
The library entries are sequentially labelled with a reference number.

GROUP ID
This entry shows which files belong to the same group. Refer to the edit section overleaf or further details.

REFERENCE NAME
A text entry, eg. Water.

FORMULA
A text representation of the formula, for example water can be shown as H_2O.

MOL WT
The molecular weight of the compound. Using the above example of water, this entry appears as '18'

P PEAK
The mass number of the Principal (major) peak in the cracking pattern for this compound.

The list of cracking patterns is split into pages of 20 entries, with the page number shown in the top right corner. To view the next page press the ↓ key; when the cursor reaches the bottom of the screen, the next page is displayed. To see the previous page, press the ↑ key; when the cursor reaches the top of the screen, the previous page is displayed.

To edit a cracking pattern (or create a new one), move the highlight to the entry to be changed, using the ↑ and ↓ keys and press *. That file is then shown in a screen editor format:

```
NAME :   Methane                    FORMULA  :  CH4
MOLECULAR  WEIGHT : 16              GROUP ID :  0
REFERENCE NUMBER  : 1          PRINCIPAL  PEAK  :  16
     MASS          INTENSITY              MASS          INTENSITY
[1 ]  1              3              [6 ]  16             100
[2 ]  12             2              [7 ]  17             1
[3 ]  13             8              [8 ]  0              0
[4 ]  14             15             [9 ]  0              0
[5 ]  15             80             [10]  0              0


Enter required data; key * to accept data and exit; key Esc to abort
```

All the allowable entry fields are shown in blue; the entries in green are for reference only.
The highlight is moved around the screen using the **Ent** key to move from one field to the next, or using the ↑ and ↓ keys to quickly move up and down the screen.

NAME
Enter a descriptive name of up to 24 characters.

FORMULA
Designed for the chemical formula, but any descriptive data (eg date) up to 16 characters can be entered.

MOLECULAR WEIGHT
Enter molecular weight to nearest integer. This entry can be left blank and is for user information only.

GROUP ID
Several library files can be grouped together to form a larger file or reduced data base.

REFERENCE NUMBER is preset and PRINCIPAL PEAK is calculated by the computer after entry of the mass and intensity data.

Mass and intensity data can be entered for the 10 highest peaks in the cracking pattern. Entries must be integer with mass limited to the mass range of the instrument and intensity expressed as a percentage with limits 0 to 100.

Enter zero in mass and intensity if less than 10 peaks are present in the spectrum.

Press **Esc** to abort the edit mode and preserve the original data.

Press * to exit the edit mode and accept the new data.

6.4.4.4. Store Current Spectrum In Library

To save the real spectrum as a library entry use option 4. The next blank entry in the library is offered to save your spectra or type in a number to overwrite an existing entry.

The highest peak in the spectrum is allocated 100%, with the next nine highest peaks scaled accordingly. The information, along with the name and formula is stored in the library.

When the information is entered the data is stored in the library file The disc drive light comes on while this is happening.

6.5. Multiple Ion Monitoring

This mode allows up to 16 mass components to be selected for analysis. A recipe is constructed specifying the mass, detector, accuracy of measurement and other storage/display features for each channel. The recipe can be stored to disk for subsequent use.

The MIM option offers a number of features to aid analysis of gaseous components present in the ion source of the mass spectrometer:

A TREND ANALYSIS

The signal of up to 16 components can be plotted on a logarithmic graph, giving immediate visual indication of any changes within the vacuum system.

B BACKGROUND SUBTRACT

The contribution from background peaks can be subtracted from the peak select data, thus allowing easy analysis of samples subsequently added to the vacuum system.

C RELATIVE SENSITIVITY

Correction factors can be entered for each component to account for the sensitivity of the analyser and efficiency of ionization. This facility can give more accurate results as not all gases are detected with the same sensitivity by the RGA.

The sensitivity of an analyser is quoted in Amps/mb for Nitrogen, ie the relative sensitivity factor for Nitrogen is 1.0. For a more detailed explanation of the factors which affect the sensitivity of a quadrupole analyser to a given gas, refer to Appendix D.

D ALARM LEVELS

High and low alarm levels can be set for any number of components, triggering the display, audible alarm and relay contacts when the alarm level is breached.

E PRINT OF DATA

If a printer interface card is installed, data collected during the run can be printed periodically according to number of cycles or time.

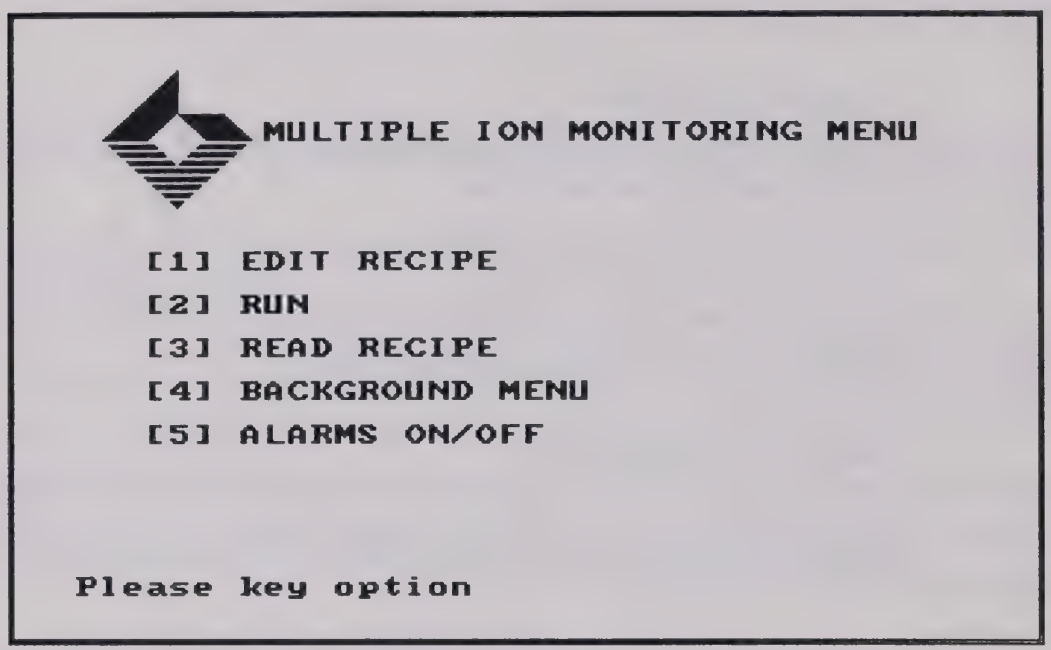
F DATA STORAGE

Some or all of the peak select can be stored to disk for subsequent analysis. Data file names are user defined.

G TIMED CYCLING

The peak select program can be set to free run, by entering a value of zero, and cycle through the measurements as quickly as they are recorded. Alternatively, the time interval between measurement cycles can be set from 100ms to 1 hour.

On selecting option 4 from the Main Menu, Multiple Ion Monitoring, a sub-menu appears:



6.5.1 Edit Recipe

Selecting option **1** from the MIM Menu leads to the Edit Recipe screen:
The screen is divided into a number of 'fields'. The highlight can be moved from one field to the next by pressing the **Ent** key. To move quickly to the field to be edited, the ← and → keys can be used to change rows, and the ↑ and ↓ keys to change column position.

There are 5 parameters at the top of the screen to define and control the 16 channel recipe below. The heading parameters are defined as follows:

1 RECIPE NAME:

This field shows the name assigned to the recipe. The name can be changed if the recipe is to be edited and stored to disk. The recipe name can be up to 8 alphanumeric characters (do not use spaces

or punctuation marks). As described previously, text entry is enabled by pressing the ? key, and edited using the **Esc** key.

2 STORE RECIPE [Yes/No]:

This field determines whether the recipe is stored to disk or not.

3 NO CYCLES [0-65535]:

The number in this field determines how long the peak select program runs before automatically aborting. An entry of **0** means the program runs forever, or until **Esc** is pressed. An entry of **1000** causes the run to stop after 1000 cycles of peak select data have been collected.

4 PRE-PEAK LOCK [Yes/No]:

The location of the mass peak top of each enabled channel can be searched and locked into memory by executing a Peak Lock routine. Select **Yes** for Pre-Peak Lock.

See later section for further details on peak locking.

5 CYCLE-PERIOD IN 1/10 SEC [0-36000]:

The time interval between cycles can be set in this field, enabling a constant data collection rate no matter what the level of signal. The interval can be set in the range 0 to 36000 1/10ths second (ie 100ms to 1 hour).

An entry of **0** sets the Run cycle to free-running, with no added software delays.

If the interval time is set less than the time it takes to complete a measurement, then the program behaves as though it were free-running, except that account is taken of the actual time of measurement when the data is plotted.

The main body of the recipe displays nine column headings which apply to each of the peak select channels:

1 CHANNEL

This column cannot be changed, it displays the pre-set channel reference number.

2 ENABLED

An entry of either **Yes** or **No** is allowed, which defines whether the channel is enabled or disabled from the measurement cycle.

Enable only those channels required, since enabling extra channels slows down the cycle time.

3 DETECTOR

This field defines the detector type, either **Faraday** for the Faraday detector or **SEM** for the multiplier.

If the multiplier is not switched on, measurements are made with the Faraday detector even though the recipe may show **SEM** for multiplier.

4 MASS

Enter the mass number (integer only) of the species to be measured on this channel. Type new mass number over existing value, ensure that no digits from previous value remain.

An entry of **0** programs a total pressure measurement.

5 NAME

This field allows the user to enter a recognisable name against a particular channel thus allowing easy identification of the mass species.

Up to 9 characters can be entered by using the text insert mode by pressing the **?** key.

6 ACCURACY

There are two fields under this heading, the first relating to accuracy of the measurement, and the second to amplifier control.

A An accuracy code from 1 to 4 is entered specifying how the measurement is performed:

1 Single measurement regardless of gain range. Fastest measurement type.

2 Normally the average of 16 readings, but this is increased for some gain ranges. Designed to provide same signal to noise performance on each gain range. Ideal general purpose accuracy code.

3 The average of 16 code-2 readings.

4 The average of 256 code-2 readings.

B The second field can either contain ***AUTO*** or ***CONSTANT***. Auto indicates that the analysis is automatically autoranging, ie under software control the amplifier is switched to the gain range most suited to the signal level. A CONSTANT entry indicates that the amplifier gain is fixed according to the range defined in column 7.

7 GAIN

This field defines the gain range used in the ***CONSTANT*** mode, or the initial gain setting in Autoranging mode.

Entries from 5 to 10 are allowed for the Faraday detector, and from 7 to 13 for the SEM.

8 REL/SENS.

A relative sensitivity factor from 0.01 to 99.99 is entered in this field. The measured signal is then divided by this factor to produce the corrected data which is displayed on the screen during RUN.

9 STORE

Some or all of the measurement cycle data can be stored to disk. This column programs whether the channel requires data storage (**Yes**) or screen only logging (**No**). If one or more channels are enabled for data storage, then a data file name is requested at the commencement of a run.

When all the functions described above are programmed and the recipe is complete, key *.

The MICROMASS PC processes the data and produces an error message if any of the field entries are invalid, if an error is found the pointer automatically steps to the box in error and awaits the entry of a new value. The screen clears to recipe storage prompts if the Store Recipe option has been selected.

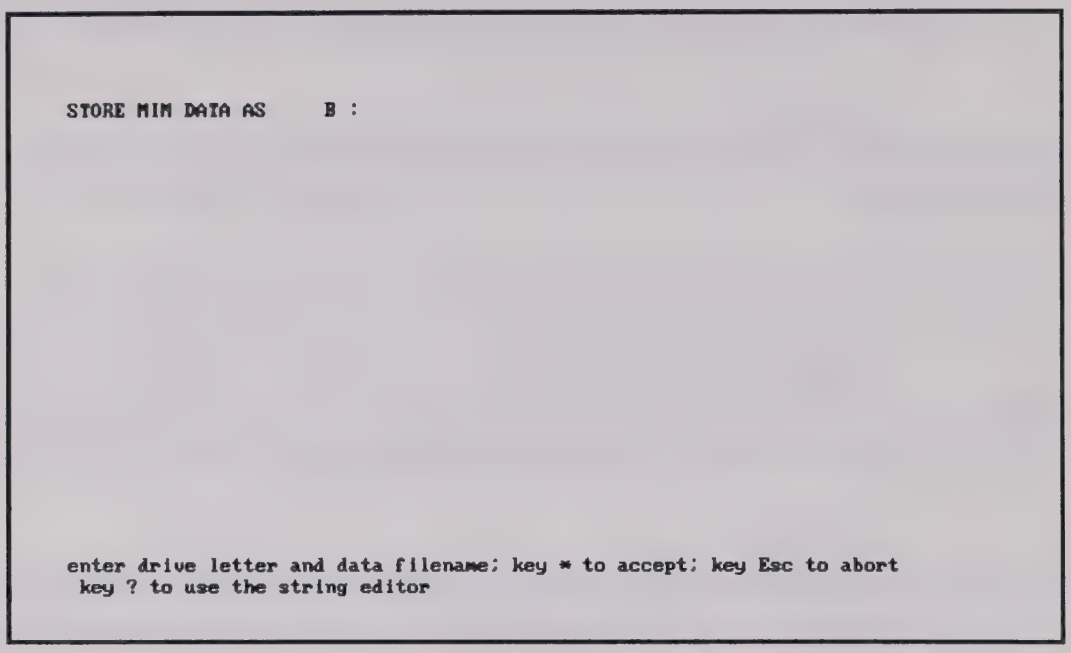
The recipe name can be changed at this stage. Press * when the desired name is shown to initiate the storage to disk.

The screen now returns to the ***MULTIPLE ION MONITORING*** (MIM) menu.

6.5.2 Run

Option 2 of the MIM menu is the main ***RUN*** routine, in which the instrument cycles through the measurements defined by the recipe.

If data storage has been requested for any of the channels, a prompt for a data filename is displayed before any further action is taken.



When the data file is created (if specified) the screen displays only the enabled channels and a flashing message at the bottom of the screen saying **please wait - to abort key Esc**. During this period the optimum gain is selected for each autoranging channel and the peak centers are locked (if Pre-Peak Lock is **Yes**). The flashing letter to the left of the channel number indicates the progress of this routine; A for Autoranging, Z for Zeroing and L for Peak Locking. When a peak is found the exact mass position according to the computers scaling is displayed in between the channel number and the mass.

At the end of this initialisation routine the MICROMASS PC prompts:

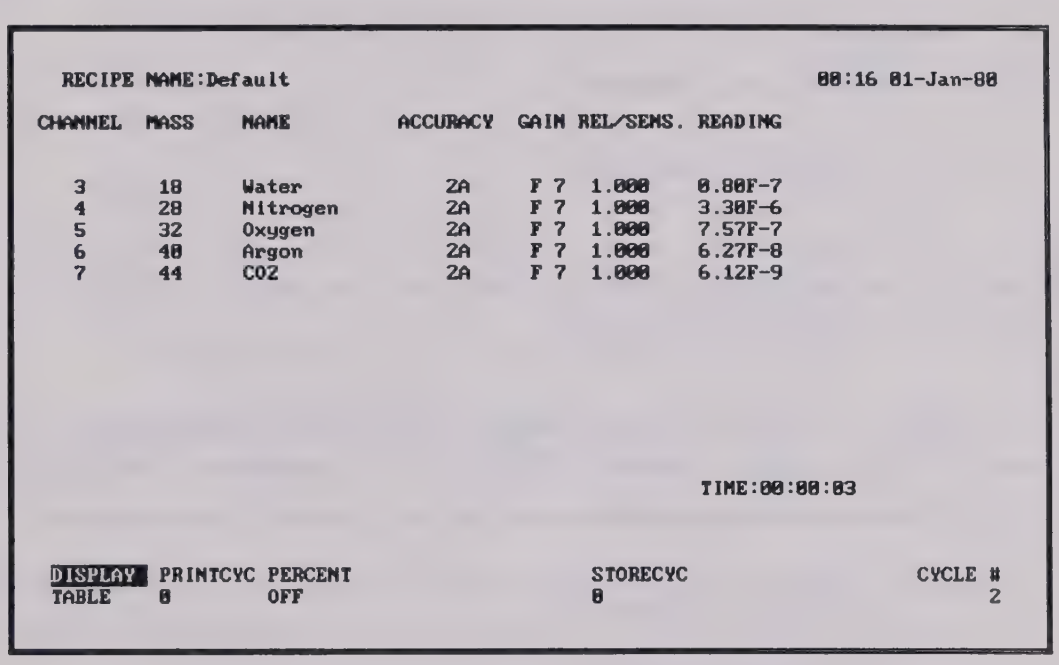
key * to start run

The instrument is ready and waiting for the signal to start the run.

6.5.2.1. Table Mode

The signal measurement is shown against each enabled channel, with the letter before the exponent indicating the detector type used for the measurement.

The cycle number and elapsed time since the ***RUN*** started are shown below the enabled channels.


RECIPE NAME:Default
00:16 01-Jan-00
CHANNEL MASS NAME ACCURACY GAIN REL/SENS. READING
3 18 Water 2A F 7 1.000 0.00F-7
4 28 Nitrogen 2A F 7 1.000 3.30F-6
5 32 Oxygen 2A F 7 1.000 7.57F-7
6 40 Argon 2A F 7 1.000 6.27F-8
7 44 CO2 2A F 7 1.000 6.12F-9
TIME:00:00:03
DISPLAY PRINTCYC PERCENT STORECYC CYCLE #
TABLE 0 OFF 0 2

At the bottom of the screen there are 9 option boxes. These options can be accessed and changed before starting the run.

1 DISPLAY

Selecting this option switches the display mode to Trend.

2 PRINTCYC

This option applies only if a printer is connected to the MICROMASS PC. Tabular data can be sent to the printer by entering a number to define the frequency of output. For example, using the ↑ key until the number in the box is 10, followed by **Ent** causes every 10th cycle of data to be dumped to the printer. Entering **0** stops the printer output.

3 PERCENT

Pressing **Ent** causes the measurements except total pressure to be expressed in percentage format. **ON** is displayed in the box. 100% corresponds to the sum of all the partial pressures of the enabled channels.

Press **Ent** again to revert to partial pressure display format, the box then shows **OFF**.

4 Not used in Table mode

5 Not used in Table mode

6 STORECYC

This option defines the frequency of data storage to disk. The default values are ***0*** (no storage) or ***1*** if data storage is programmed in the recipe.

An entry value of ***1*** means that every measurement cycle is stored, while an entry value for ***10*** programs every 10th cycle to be recorded. The STORECYC frequency can be changed during the Run. Press **Ent** after updating the number using the ↑ or ↓ keys to effect the change.

7 Not used in Table mode

8 Not used in table mode

7 Not used in Table mode

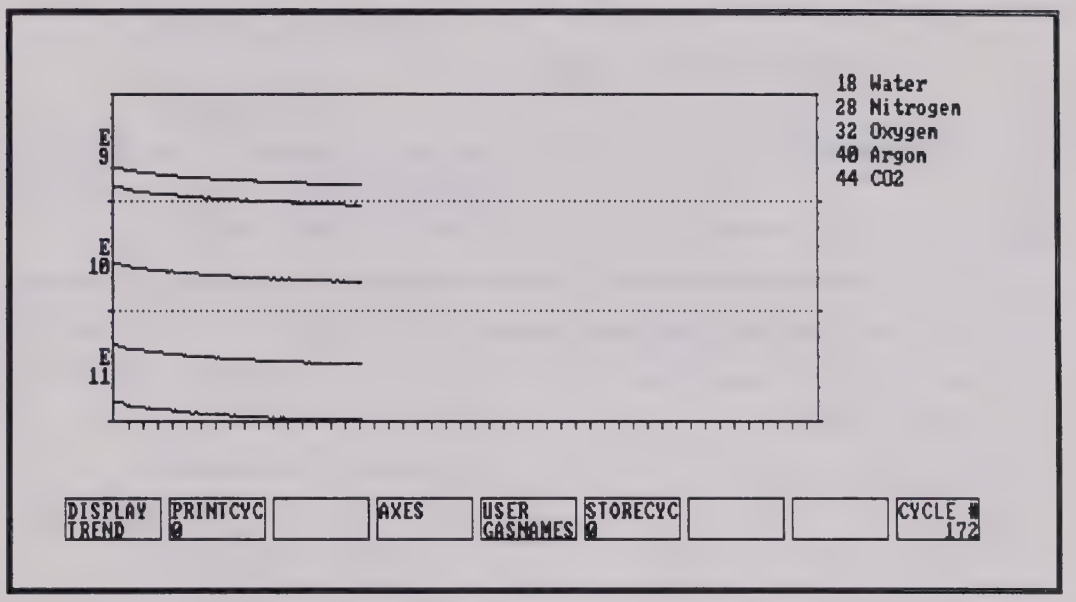
8 Not used in Table mode

9 CYCLE #

This box displays a running count of how many measurement cycles have been taken since the start of the run.

6.5.2.2. Trend

This display mode is accessed from the MIM RUN option and gives a logarithmic graphical representation of the output of all enabled channels:



The masses and names of the selected channels are shown in up to 16 separate colours beside the graph. Lines of corresponding colours map the pressure changes for that compound.

The dynamic range covered and the detector type are depicted along the y-axis. The x-axis is scaled and labelled as a linear elapsed time axis if a timed cycle has been specified, otherwise the cycle number is displayed.

If the printer option is fitted, a dump of the screen image can be made at any time by pressing the **Prt** key.

At the bottom of the screen are 4 option boxes similar to the Tabular display.

1 DISPLAY

Selecting this option by pressing **Ent** reverts the screen display to the Tabular mode.

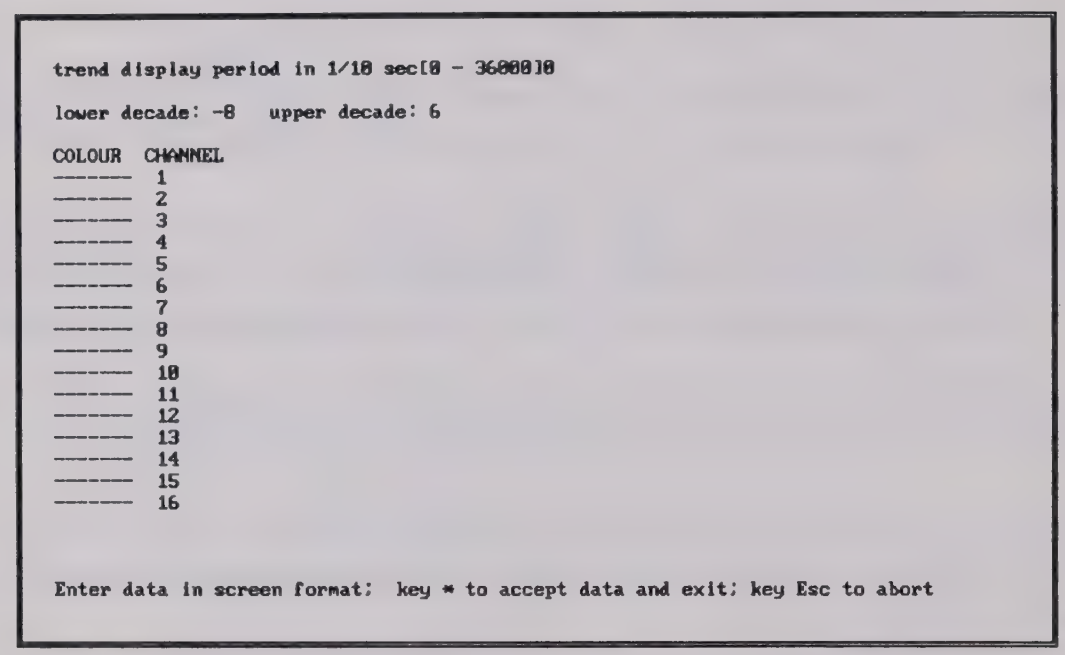
2 PRINTCYC

This option applies only if a printer is connected to the MICROMASS PC. Tabular data can be sent to the printer by entering a number to define the frequency of output. For example, using cursor up until a value of **10** is reached followed by **Ent** causes every 10th cycle of data to be dumped to the printer. Entering **0** stops the printer output.

3 Not used in Trend mode

4 AXES

This option leads to a screen editor menu which defines the display parameters.



The entry highlight can be moved through the parameter options with the **Ent** key. The ↑ and ↓ keys allow quick movement between rows.

The top line defines the time interval used for plotting the data. This value defaults to the same as set in the recipe. The plotting interval can be changed whilst retaining the data acquisition rate previously defined. A value of zero is used for 'free running'.

The second line defines the y-axis parameters. The number of decades can be set by defining the lower and upper decades to be displayed. The limits are -5 (upper) to -13 (lower).

The pressure axis is normally displayed in a quasi log format, however, if you select an axis with a single decade (ie uppergain = lower gain) then the pressure axis will be in a linear format.

When editing of the display format is complete key * to return to the re-defined trend display screen.

5 USER GAS NAMES

6 STORECYC

This option defines the frequency of data storage to disk. The default values are ***0*** (no storage) or ***1*** if data storage is programmed in the recipe.

A value of ***1*** means that every measurement cycle is stored, while a value of ***10*** programs every 10th cycle to be recorded. The storage frequency can be changed during the Run. Press **Ent** after updating the number to effect the change.

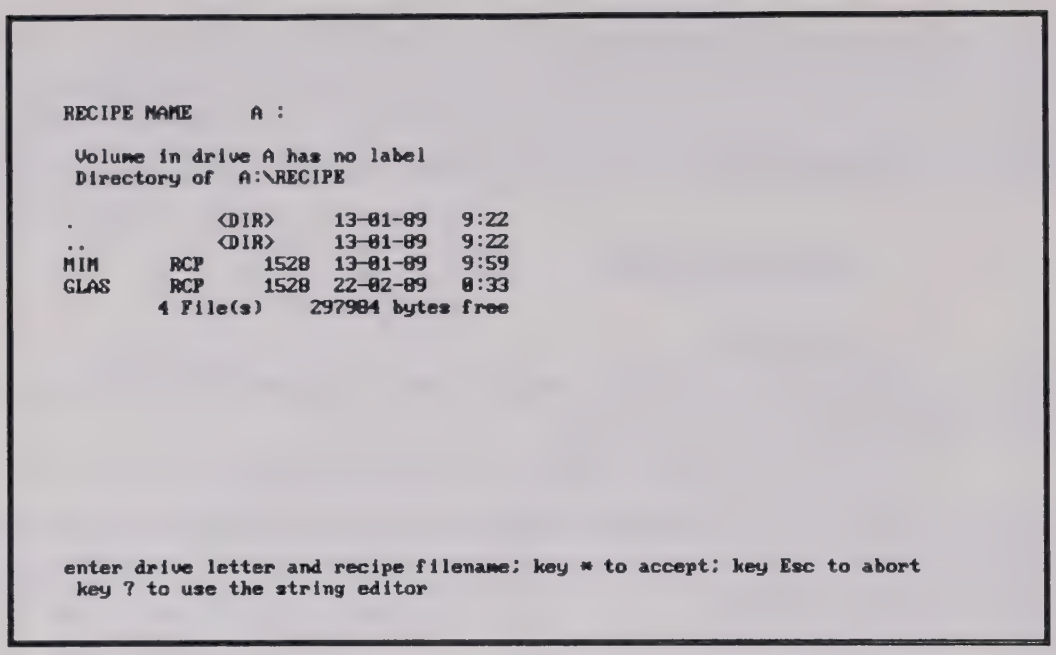
7 Not used in Trend mode

8 Not used in Trend mode

9 CYCLE #

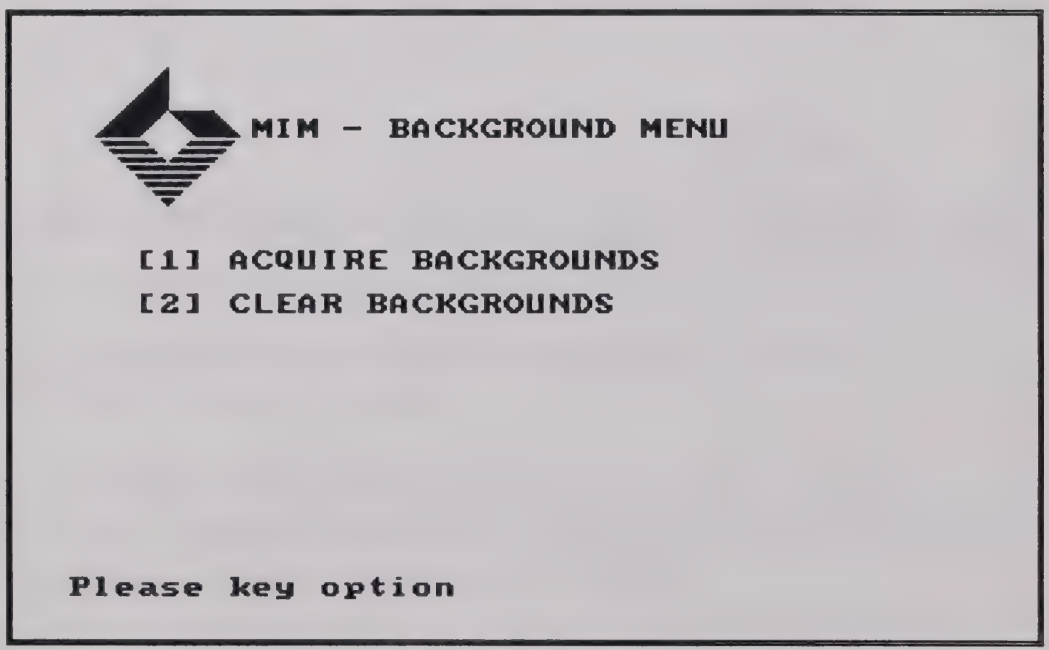
6.5.3 Read Recipe

This option allows a recipe stored on disk to be read into memory. A filename of an existing recipe is requested (as overleaf):


RECIPE NAME A :
Volume in drive A has no label
Directory of A:\RECIPE
. <DIR> 13-01-89 9:22
.. <DIR> 13-01-89 9:22
MIM RCP 1528 13-01-89 9:59
GLAS RCP 1528 22-02-89 8:33
4 File(s) 297984 bytes free
enter drive letter and recipe filename; key * to accept; key Esc to abort
key ? to use the string editor

6.5.4 Background Menu

Selecting option 4 from the Peak Select Menu leads to a further sub menu:



6.5.4.1. Acquire Backgrounds

This mode resembles a ***RUN*** screen except that data is collected to record the average background measurements at each enabled mass. If the ***CYCLES*** entry in the Recipe is zero, the background values are taken as the average of 16 measurement cycles. If the ***CYCLES*** value is non-zero, that many measurement cycles are averaged.

The letters **BG** are shown on the screen to indicate that background measurements are being recorded. At the end of the routine the average readings are displayed; press **Esc** to return to the Menu. Subsequently all data is corrected by subtracting this background data from the measurements recorded during a run.

6.5.4.2. Clear Backgrounds

Selecting this option clears the background values from memory and thus 'switches off' Background Subtraction. The screen immediately returns to the Background Menu.

Press **Esc** to return to the MIM Menu.

6.5.5 Alarms

The alarm facility is only available in the MIM mode of operation and allows the user to set pressure limits (both partial and total) which when breached alter the state of relay outputs for HIGH and LOW levels.

The facility is toggled ON/OFF by repeated presses of '6' ion the MIM sub-menu. The current state either ON/OFF is shown in yellow text.

When you complete the edit recipe page, if the Alarm facility is enabled then the next page displayed is the "Edit Alarms" page. You are first asked to specify if the units for alarm levels are to be in partial pressure or percentages, and press * to confirm your choice.

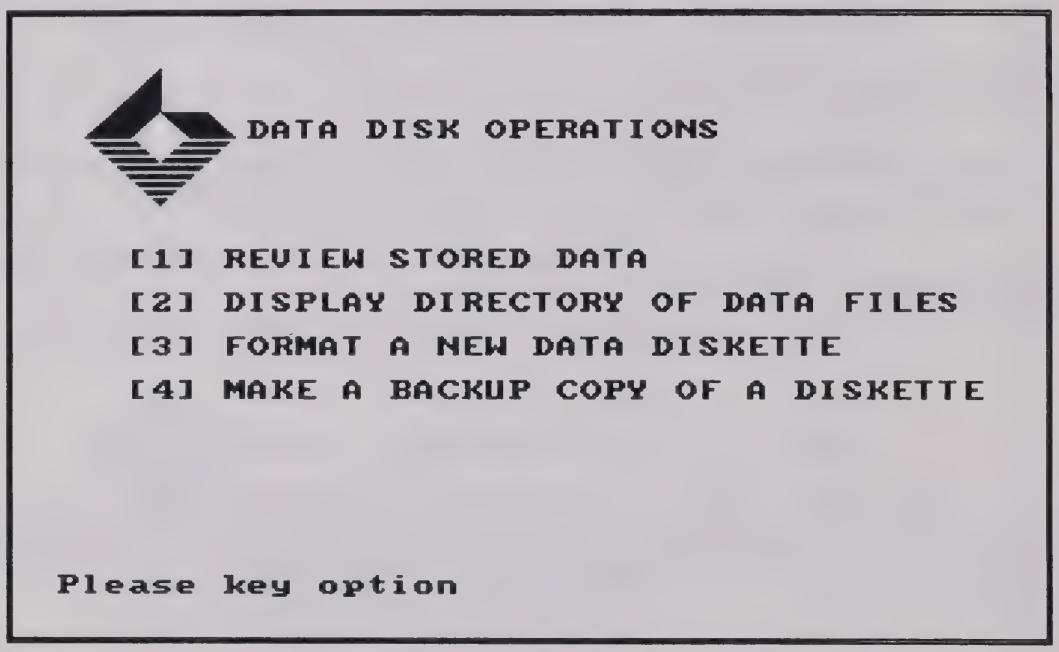
The actual alarm edit page, shows the channel you have enabled and allows you to set values within the limits of the detector you have selected.

When in the RUN mode of MIM, the alarm levels you have set will be compared to the pressure/percentage readings being measured, and if any limit is breached then the words LOW and HIGH will be displayed in the ALARM column, and the corresponds relay will change state accordingly.

To prevent relay "chatter" there is a built-in hysteresis of 10% of signal value when alarm levels are crossed.

6.6. Data Disk Management

Options are selected from a sub-menu:


DATA DISK OPERATIONS
[1] REVIEW STORED DATA
[2] DISPLAY DIRECTORY OF DATA FILES
[3] FORMAT A NEW DATA DISKETTE
[4] MAKE A BACKUP COPY OF A DISKETTE
Please key option

6.6.1 Review Stored Data

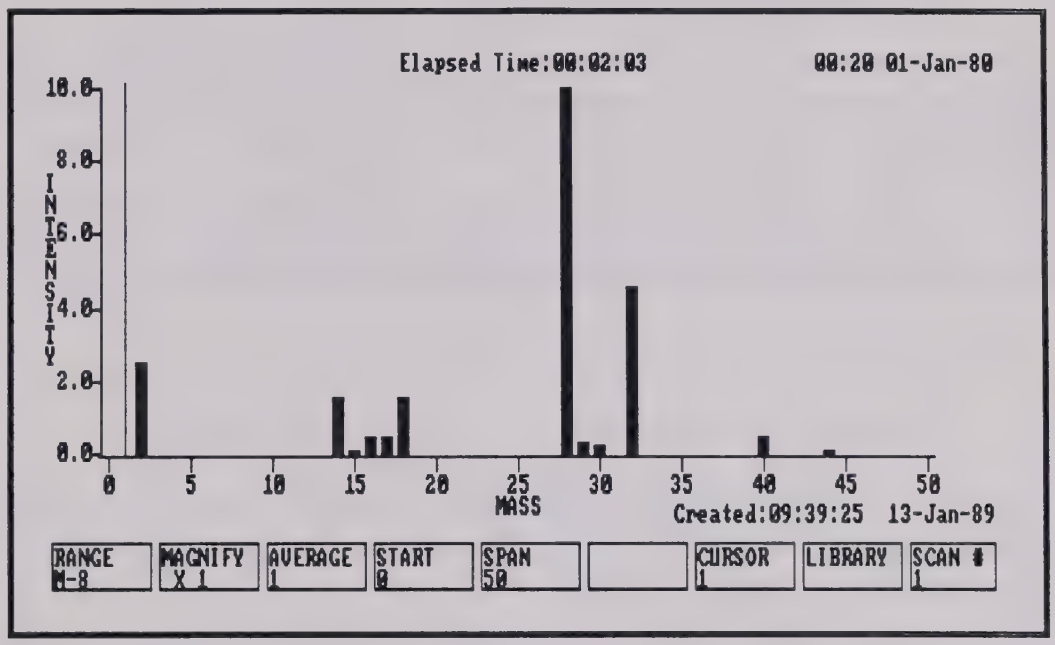
Selecting option 5 from the Main Menu leads to the data retrieval and display program. This allows data collected to be reviewed.

A directory of Data Files is displayed, and a prompt is displayed for a datafile name.

As the datafile is loaded the number of stored cycles is calculated and displayed on the screen.

The program automatically determines the data type (which type of scan mode) and displays the appropriate screen. To advance through the data, go to the function box marked 'SCAN #', and press the ↑ key. To go backwards, use the ↓ key.

Histogram and Analogue data review is operated in a similar manner to the real time mode.



The function boxes available to control the data are;

1 RANGE - not accessible, only shown for reference.

2 MAGNIFY

3 AVERAGE - not accessible, only shown for reference.

4 START

5 SPAN

6 STORE - not accessible, only shown for reference.

7 CURSOR

8 LIBRARY

9 SCAN #

Likewise MIM data review is almost the same as a real time run.

Press **Esc** to return to MAIN MENU

6.6.2 Display Directory Of Data Files

The user is prompted to insert the disk containing the directory entries for any DATA and RECIPE files in the drive. The results of this operation will stay on the screen until the user presses a key to continue.

If the disk is not in the drive, or the drive door handle is not fully in position, an error message is displayed A prompt to correct the error is displayed and then press the **?** key to continue.

6.6.3 Format A New Data Disk

To be able to store spectra on a blank disk, it first must be prepared to accept data, this operation is called disk formatting. The type of blank disk(s) you require are "double sided, double density, 48 TPI" for a 5¼ " unit, and 720K for 3 ½" drives.

CAUTION: If re-cycling an existing disk, any information already on disk will be deleted, and cannot be recovered.

The formatting operation checks the disk media surface is free from defects and writes a structure to the disk allowing storage of both DATA and RECIPE files.

After the first disk is formatted, cancel the operation by pressing the **0** key, following the instruction on the screen.

6.6.4 Making A Copy Of A Diskette

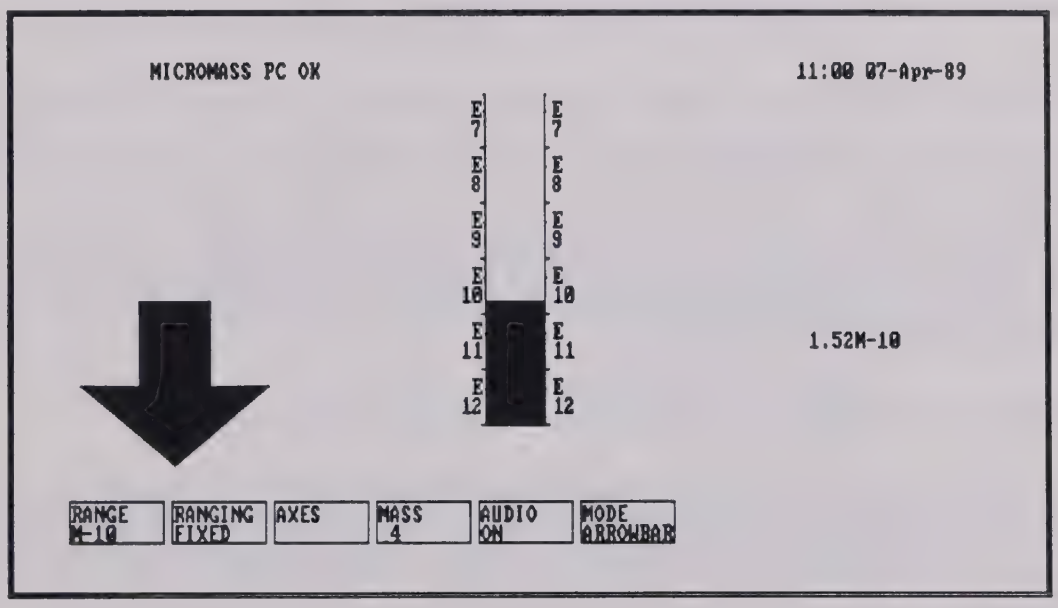
To protect the master or "source" disk against accidental erasure on a 5¼", place a "write-protect" sticker over the small notch on the edge of the disk jacket (not over the disk surface) and on a 3 ½" disk slide the black insert in the case.

The user is then prompted on the screen to insert your "SOURCE" disk and blank "DESTINATION" disk alternately.

Press the **0** key to cancel the operation when prompted on the screen.

6.7. Leak Detection

Leak detection mode allows the user to isolate the source of a leak and minimise down-time of the system. The mode is controlled by the parameters in the function boxes. The partial pressure of the gas in the system is shown graphically as a column, with a corresponding digital read-out on the right hand side. If the screen cannot be seen, use the loud speaker output. If totally remote from the instrument then an analogue output is available via the chart recorder output for feeding to a DVM.



1 RANGE

Use the ↑ and ↓ keys to alter the gain accordingly.

2 RANGING

Use the **Ent** key to toggle between FIXED and AUTO gain range.

3 AXES

This page allows the user to set which gain range or ranges are displayed.

For a fine leak you would set a single decade axis to see small variations. For a gross leak use a three or four decade plot depending on the size of leak.

Press * to implement the changes.

4 MASS

The default MASS is 4 (for Helium), but this can be changed to any other desired mass (within the range of the instrument) by using the ↑ and ↓ keys and pressing **Ent** to confirm.

5 AUDIO

An audible leak signal is provided via the loud speaker on the instrument. Use the **Ent** key to switch this ***OFF*** or ***ON***.

6 MODE

Press Ent to toggle between ***ARROWBAR*** and ***TREND*** screen displays.

ARROWBAR shows a yellow box for a static pressure reading, if the signal intensity rises indicating more trace gas entering the system a bold up arrow is displayed in red, if the leak is cured and the trace gas is pumping away (a good condition) then a bold green down arrow is displayed as long as the pressure trend is continued. TREND switches screen display format to a style similar to that used in MIM. The partial pressure for the mass selected is plotted against time, over the pressure range(s) selected from ARROWBAR.

This leak detection mode can equally be used as a Single Ion Monitor.

The pressure intensity signal is also provided via the chart recorder output (SKT5) as a voltage from 0 to 10 V for the decade in which the reading is taken. For example a reading of 5.3 $x10^{-7}$ would appear as 5.3 V.

Pressing **Esc** leaves Leak Detect mode, and returns to the main menu.

7. INSTRUMENT FUNCTIONS

7.1. Principles Of Operation

The Micromass PC is a vacuum analyser which will measure total pressure and partial pressure. The ranges of operation will depend on the model you have purchased. The analyser can be operated up to 10^{-3} mbar, but prolonged use at these high pressures is not recommended.

The analyser is a quadrupole mass spectrometer, which is capable of separating the ions formed in an electron impact source according to their mass-to-charge ratio. The power to the analyser may also be arranged so that the whole ion beam is transmitted, thereby producing a collected ion current approximately proportional to the total pressure. The signal collector can be of the Faraday cup or SEM type.

A general explanation of the operation of the instrument is given in Appendix C.

7.2. Front Panel Controls

The white rocker switch on the front of the unit is used to switch mains to the controller. It is a double pole switch and therefore makes or breaks both the nominally live and nominally neutral lines. The live line is fused with a 3A anti-surge fuse. When electrical power is switched to the unit, an internal PSU generates 5V DC which powers a green LED on the front panel.

Switching power to the unit initiates a self test routine of the processor board; the start of this is heard as a beep from the unit. Whilst the memory on the board is being tested, a counter cycles from zero to 512K. The system operating software is then transferred from disk into memory; whilst this takes place a header page showing the VG logo is displayed. The special electronics are then initialised followed by a display on the monitor for the Command page.

If the unit is bench mounted angle the front panel for a better viewing angle by raising the tilt feet under the front on the instrument.

7.3. Rear Panel

7.3.1 Analogue Input/Output Connections

SKT2 is a 25-way, D type socket for the analogue input/output option (if fitted).

The pin-out for this connector is:

1	Digital Output 1
2	Digital Input 1
3	Digital Output 3
4	Analogue output channel 3 (8 bit)
5	Analogue output channel 4 (8 bit)
6	Analogue Input Ground
7	Analogue output channel 1 (12 bit)
8	Analogue output channel 6 (8 bit)
9	Analogue output channel 9 (8 bit)
10	Analogue output channel 10 (8 bit)
11	DAC 0 V
12	-15 V
13	0 V (P)
14	Digital Input 2
15	Digital Output 2
16	0 V (D)
17	Analogue Input 1
18	Analogue Input 2
19	Analogue output channel 2 (12 bit)
20	Analogue output channel 5 (8 bit)
21	Analogue output channel 8 (8 bit)
22	Analogue output channel 7 (8 bit)
23	DAC 0 V
24	DAC 0 V
25	+15 V

7.3.2 MP8X Multiplexer Control

SKT3 is to control a VG MP8X (if option is fitted)

7.3.3 Valve Driver

PL4 is used only with the Valve driver option.

7.3.4 Auxiliary Input/Outputs

SKT5 provides signals for driving the chart recorder, and for inputting a vacuum good signal to the controller. The pin-out of this connector is as follows;

Pin	Function
1	Scope Y
2	Ramp voltage (X)
3	Chart signal (Y)
4	0 V
6	0 V
8	+5 V, Max current 100 mA
9	Vacuum Interlock

Vacuum interlock is a TTL input normally left floating, but if this line is pulled down to ground potential, it triggers a vacuum failure signal to the Micromass PC, and trips the emission circuit.

7.3.5 Alarms

PL6 is the Painton plug, providing two sets of relay contacts for high (Relay 2) and low (Relay 1) alarms. The conditions under which these relays are active depend on user settings in the MIM mode. These levels can be set on partial pressure, percentage modes and user values for analog inputs.

RL1	1 - COMMON
	3 - NO (Normally open)
	5 - NC (Normally closed)
RL2	2 - COMMON
	4 - NO
	6 - NC

7.3.6 Slot Card Connections

Slot cards fitted to the processor board are labelled as S1 to S8. Connection to the RF generator is via S8. S1 is the graphics card, S2 is the disc drive controller card. Depending on options ordered, more cards may be fitted.

A parallel printer interface card has a 25 way D type connector of the female type. There are no user settings to be carried out on this card. The pin out of this IBM compatible card is:

1	Strobe	11	Busy
2	Data bit 0	12	Paper end
3	Data bit 1	13	Select
4	Data bit 2	14	Autofeed
5	Data bit 3	15	Error
6	Data bit 4	16	Initialise Printer
7	Data bit 5	17	Select input
8	Data bit 6	18-25	Ground
9	Data bit 7		
10	Acknowledge		

A normal IBM compatible parallel printer cable is suitable.

The RS232 card also has a 25 way D type male connector. Depending on the option ordered the card operates in a number of modes;

- ❒ output to a serial printer
- ❒ output to a serial plotter (HPGL Compatible)
- ❒ remote control communications

The RS232 card has a number of DIL switches preset at the factory to suit the documentation supplied. Refer to the technical manual for further details.

7.3.7 Cooling Fan

Located on the rear panel is a 62mm fan, powered from 12V DC on the Switch mode PSU and used to cool the electronics in the controller. The fan draws air in through a filter to avoid the intake of dust etc. At a rate depending on the environment, the Micromass PC is used in, the fan filter will gradually become dirty and need replacing. If the change of filter is left too long, the fan will become in-effective in its cooling action.

NOTE: **The fan filter must be regularly inspected. Place a flat-blade screwdriver in the slot on the filter cover, twist the screw by a quarter turn and pull off the cover, the filter can then be pulled out.**

7.3.8 Voltage

There is an internal PCB capable of re-tapping the instrument to any one of four common voltages. This board must only be removed with the power lead removed. The board is secured by a cable tie, and a new cable tie must be used to secure the board after any changes.

Depending on the model of colour monitor fitted to the unit, there may be a separate switch to 're-tap' the monitor. This switch is on the outside of the end plate, towards the rear of the unit.

7.3.9 Power Input

The power input (PL1) is a three pin IEC recessed plug. A mating mains lead is supplied with the Micromass PC and requires a suitable plug for the mains outlet.

Observe the colour coding:

ERD KLEMME	GRUN/GLEB
EARTH	GREEN/YELLOW
TERRE	VERT/JAUNE
STROMF UHRED	BRAUN
LIVE	BROWN
SOUS TENSION	BRUN
NEUTRAL	BLAU
NEUTRAL	BLUE
NEUTRE	BLEU

For the USA;

EARTH	GREEN
LIVE	BLACK
NEUTRAL	WHITE

7.3.10 Fuses

The Micromass PC has one externally accessible 3A anti-surge fuse in the live line, fitted to the rear panel.

A number of other fuses are used on the power supplies card as follows;

FS1	1.6 A anti-surge	FS2	100 mA anti-surge
FS3	1.6 A anti-surge	FS4	250mA anti-surge

WARNING: FUSES MUST ONLY BE REMOVED OR REPLACED WITH THE POWER LEAD REMOVED.

7.4. Colour display

The display monitor is of the RGBI style with a 10" tube and can show sixteen colours.

WARNING: AS ON ANY MONITOR OR TELEVISION, HIGH VOLTAGES EXIST, BUT ARE SHIELDED FROM THE USER BY THE TOP COVER. THERE ARE NO USER ADJUSTABLE SETTINGS, EXCEPT FOR THE BRIGHTNESS CONTROL LOCATED BROUGHT ON THE OUTSIDE OF THE REAR PANEL.

7.5. Key Pad

The key pad comprises 20 keys connected in a matrix to a single chip microprocessor controller. The controller IC has all the necessary circuitry to interface between the keys and generate the right key codes in a serial format as required by the motherboard. A 6MHz crystal is used to generate all timing signals and this is de-coupled by two 27pF capacitors. The reset circuit comprises a 10uF capacitor and an IN4148 diode.

All key presses are detected by the microprocessor board on the main motherboard as interrupt calls, a software routine then sounds an audible beep to confirm the key press to the user.

7.6. Motherboard

The main board is a double sided PC compatible unit, measuring approximately 8 x 12 inches, with eight 62 pin card edge sockets. Four sockets are used to control the Micromass PC; these are the graphics display card, disk drive controller, PSU card and interface card. More cards may be fitted if options are fitted.

The system board contains the electronics for attaching the serial interface from the key pad; the interface can request execution of a diagnostic test in the key pad. The key pad connects via a 5 pin DIN connector as follows:

pin 1	keypad clock
pin 2	keypad data
pin 3	keypad reset
pin 4	Ground
pin 5	+5 VDC

The board uses a NEC V20/8088 processor running at 10MHz, with 512K RAM (Random Access Memory). Depending on options supplied, this can be expanded by VG Quadrupoles to 640K.

Fitted to the motherboard is a battery backed real time clock and calendar designed for 10 year operation. The time and date held by the unit can be altered using the system software.

8. ANALYSER HEAD MAINTENANCE

No routine maintenance of the Micromass PC analyser head is required unless it becomes necessary to replace the filament assembly or excessive contamination is present.

8.1. Replacing the Filament Assembly

CAUTION: Precautions must be taken to ensure clean working conditions. Clean nylon or cotton gloves must be worn when handling any part of the analyser which is immersed in the high vacuum.

Should finger grease contaminate any part of the analyser, the whole assembly must be cleaned.

The filament in the Micromass analyser head can be quickly and simply changed by the user. Spare filaments are available from VG Quadrupoles at the address on the front page of the manual or from the local agent.

Switch off the Micromass PC control unit. Disconnect the multi-core cable from the remote head. Remove the remote head from the analyser by first unscrewing the plastic coupling nut and then carefully withdrawing the remote head from the feedthrough flange, making sure that the feed-throughs are clear of the remote head before removing the head.

Shut down the high vacuum pumps or isolate that part of the system containing the analyser head.

Unscrew the six nuts and bolts and carefully withdraw the analyser from the vacuum port. Cover the port.

Support the Micromass analyser head in a vertical position when changing the filament.

Wearing clean gloves, loosen the three M1.6 cheesehead screws clamping the barrel connectors on the top of the analyser to the pin protruding through the disc (see Figure on VIII- 59)

Ease off the barrel connectors and gently move the ceramic-shielded wires away from the analyser body to clear the source.

Unscrew and remove the two M1.6 cheesehead screws and washers which clamp the filament assembly to the repeller.

Carefully withdraw the filament assembly axially. Insert the new filament assembly taking care not to damage the delicate source cage.

The Micromass PC filaments are factory pre-aligned and require no alignment or adjustment. Replace the two screws to clamp the filament assembly to the repeller and tighten them lightly.

Place the barrel connectors on the pins and tighten the clamping screws. Ensure that the barrel connector is not pushed against the lead retainer at the base of the filament wire.

Re-install the Micromass PC in accordance with instructions in section 4.2 using a new copper gasket.

NOTE: **All necessary tools, including nylon gloves and a supply of copper gaskets, together with 3 spare filament assemblies, are included in the Micromass Filament Tool Kit available from VG Quadrupoles or the local agent.**

8.2. Non-Standard Filament Materials

The Micromass PC can be supplied with filament wire of a material other than the standard Thoriated Iridium. The available options are Rhenium or Tungsten.

Thoriated Iridium emits electrons at a much lower temperature than either Tungsten or Rhenium (it has a lower work function) and so requires less current supply to the filament in order to produce the pre-set electron emission current. When using other filament materials, the filament current limit should be increased to provide sufficient emission for control.

The Micromass may now be operated normally in accordance with the operating instructions herein.

CAUTION: **Lanthanum Hexaboride filaments require special treatment before use and reference must be made to the Technical Information Sheet that accompanies every shipment of these special devices.**

8.3. Cleaning The Analyser Head

If the Micromass head become contaminated with pump oil or finger grease it may be cleaned as described below. Remove thoriated iridium filament assemblies as the thoria coating can be dislodged if subject to prolonged agitation.

For Faraday analysers only, immerse the complete analyser head in a beaker of clean Arklone 'P', acetone, propanol or trichlorethylene.

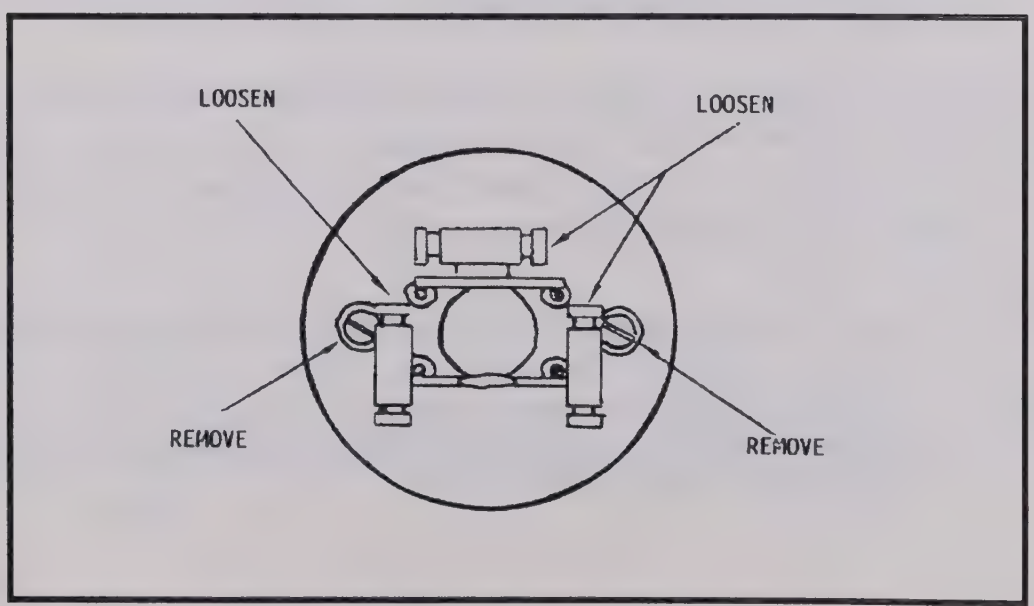
For Dual Detector (SEM) analysers, immerse the filter part of the analyser in a beaker of clean Arklone 'K' acetone or propanol, but **not** the part of the analyser containing the electron multiplier.

Place the beaker in an ultrasonic cleaning bath for 20 minutes.

Remove the analyser from the cleaning fluid and allow excess fluid to drain off. Place the head in a clean drying oven at 80^{o}C for 2 hours.

Use clean nylon or cotton gloves to handle the clean analyser.

Should the above procedure not remove the contamination, it may be repeated and failing that the analyser head should be returned to the factory for a thorough clean and re-build if necessary. Factory repairs are accompanied by a report when requested to suggest safeguards against repetition.



9. INSTRUMENT ADJUSTMENT

The series of calibration must be carried out at yearly intervals with Micromass PC at its normal running temperature.

9.1. Control Unit

9.1.1 Current Limit

To alter current limit, disconnect the 37 way connector from the controller, connect an ammeter capable of 5A operation across the test points marked FIL- and FIL+ on the top right corner of the PSU board. From the command page, key **Ent** over the emission box, and adjust pot VR5, labelled CL (current limit) for the correct setting for the filaments in use.

Thoria filaments - current limit 2.2 A.
Tungsten filament - current limit 3.1 A.
Rhenium filament - current limit 3.1 A.

9.1.2 Ion Energy

The pot' (VR2) and test point (IE) are on the top left hand corner of the PSU board. The voltage depends on the mass range of the instrument, normal settings are 3.5V for 100 amu units, and 5.0 V for 200 and 300 amu units.

9.1.3 RF Voltage

This is monitored between +RF and -RF test points, and adjusted by VR4 (set V).

100 amu unit, V = 33V
200 amu unit, V = 85V
300 amu unit, V = 135V

9.2. RF Generator

see separate section

9.3. Re-tuning your instrument

9.3.1 Check Current Limit as described above

9.3.2 Check RF Voltage as described above

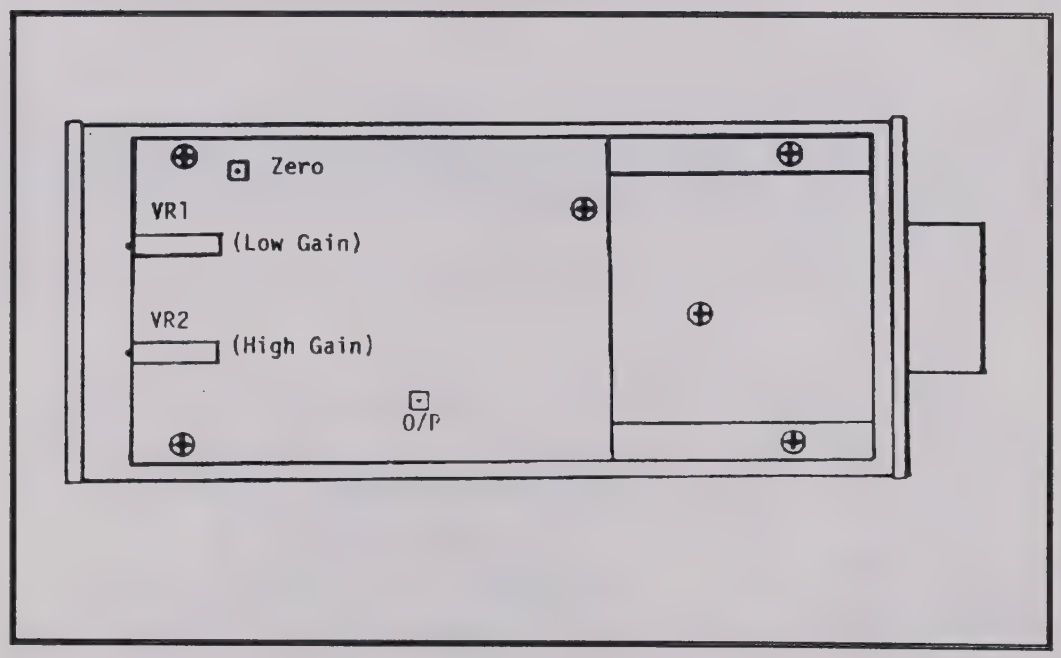
9.3.3 Check DC Voltage

In analogue scan, set 1st mass = 198 (99 on 100 amu units) and span = 2, allow unit to scan then press ESC. The "bal" trim pot in the RF generator should be adjusted to give equal and opposite polarity voltages at the two test points +DC and -DC when measured with respect to V.

NOTE: Measure the -DC test point first, then equalise whilst monitoring the +DC test point.

9.3.4 Amplifier Zero

Set amplifier zeros using the routine of the Utility disk to be made available.

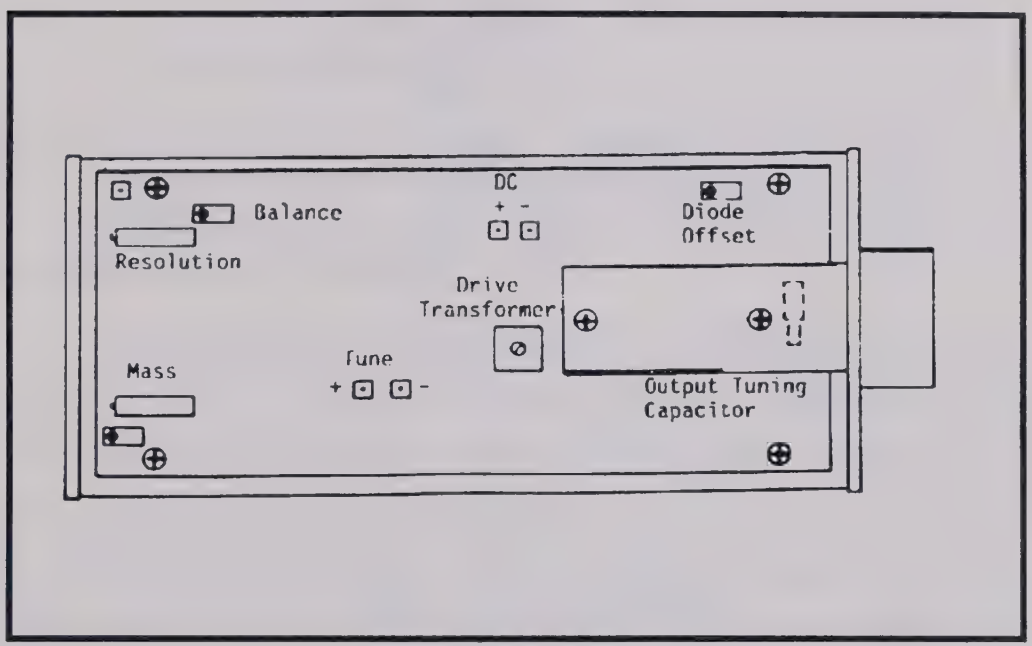


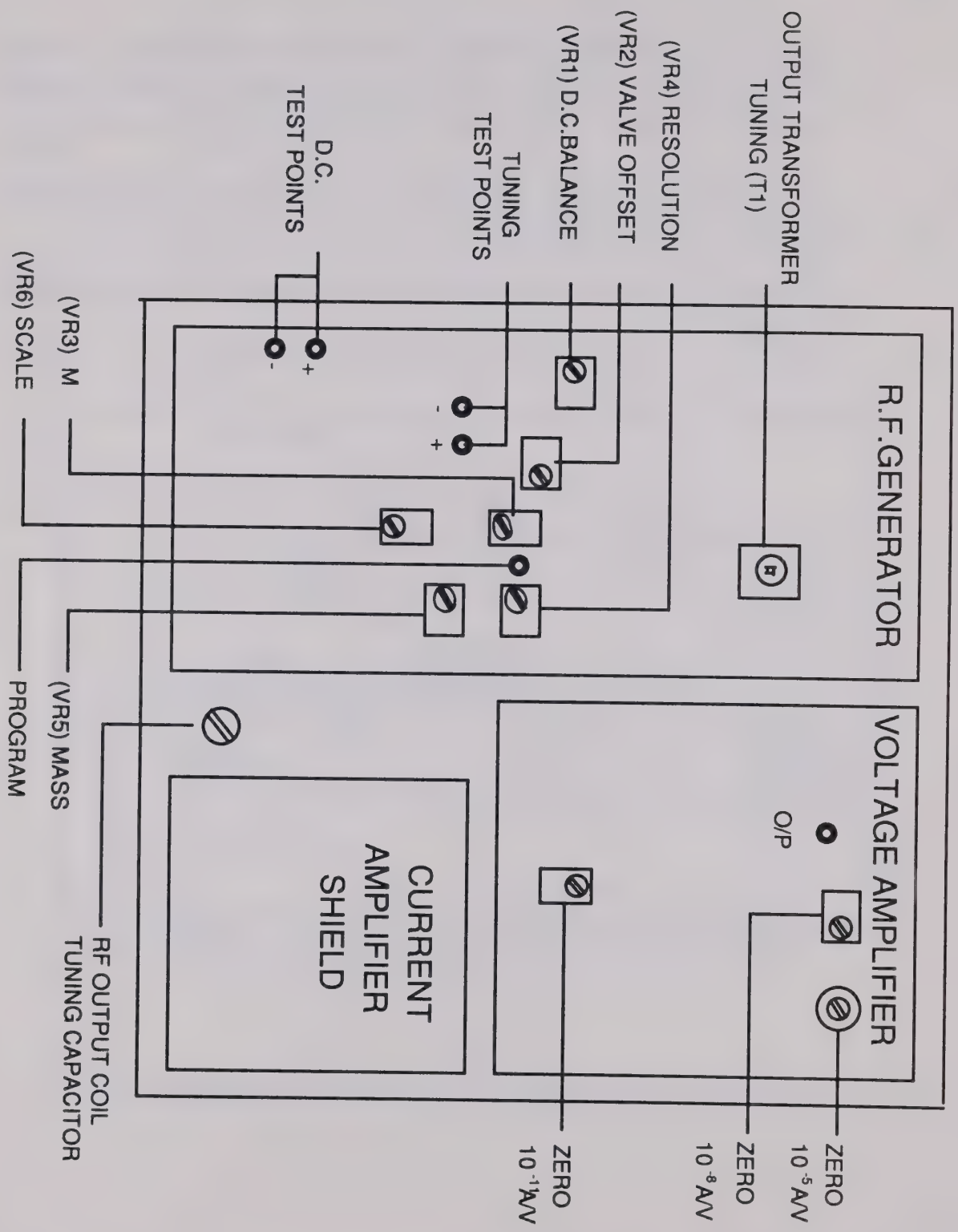
9.3.5 Resolution and ΔM

1 Use Analogue scan to display from mass 12 to 20. Adjust "ΔM" (VR3) in the 200/300 amu RF generator and "diode offset" in the 100 amu RF generator. For correct resolution (the valley between adjacent peaks just rising off the base line) with the water group.

2 Alter the start mass, to display another group of peaks with higher masses, increasing gain if necessary. Then adjust "RES" (VR4) for correct resolution.

3 Repeat 1 and 2 until no further improvement can be made at the highest discernable masses.




R.F.GENERATOR
OUTPUT TRANSFORMER TUNING (T1)
(VR4) RESOLUTION
(VR2) VALVE OFFSET
(VR1) D.C.BALANCE
TUNING TEST POINTS
D.C. TEST POINTS
(VR3) M
(VR6) SCALE
(VR5) MASS
PROGRAM
VOLTAGE AMPLIFIER
O/P
ZERO
10 -5 A/V
ZERO
10 -8 A/V
ZERO
10 -11 A/V
CURRENT AMPLIFIER SHIELD
RF OUTPUT COIL TUNING CAPACITOR

9.3.6 Mass Scale Alignment

If the locked peak center is greater than 0.25amu from the theoretical value, re-adjust the mass scaling.

Use analogue scan to display from mass 12 to 45. Adjust "scale" pot to line up the water peaks with the mass scale. Then use "mass"pot to align the peaks at higher masses.

The two controls interact with each other, therefore the procedure must be repeated as necessary. The "mass" pot should be set using the highest mass detectable.

9.4. FAULT FINDING GUIDE

When the Micromass PC controller is first switched on, an internal PSU provides a 5V DC signal to power the front panel LED, if this is not lit check all the DC power rails (ie +5 V, +12 V, -5 V, -12 V). These are located on a 12 way molex connector at the rear right hand side of the processor board and are labelled on the PCB legend.

The DC power rails supplied from a switch mode PSU have the advantage of being compact and relatively cheap, but they must always be used under load, ie they CANNOT be used open circuit and must be connected to the processor at all times to avoid destruction. If there are no DC outputs check that the correct mains voltage is being fed to the unit. If the controller has all the right DC voltages going to the processor board, then it will proceed to initialise itself. This self diagnostic test routine does not at this stage include any tests on the RGA electronics. While the processor board is proceeding through its tests, the MICROMASS PC text is displayed on the top line of the monitor.

If no text appears on the screen after 30 seconds adjust the brightness pot on the rear panel, then check that the 9 way connector is properly screwed into slot card 1 (on the LHS). Check also that the other end of the cable is properly connected to the monitor - these tests on the monitor must be carried out with the mains disconnected to avoid any high voltages on the monitor supplies.

As the tests progress, the processor checks the amount of memory fitted to the processor board, and counts from zero up to 512K (if the plotter option is fitted then this figure is 640K).

If there is a bad connection to the key pad an error message is printed out. Check that the 5 pin DIN plug is connected through the back panel into the processor board. The key pad is controlled via a single chip Microprocessor, check that this is properly seated in its socket.

Once the processor board diagnostics are complete (which only takes a few seconds) an attempt to load the system programs from disk is made. The system disc must be in the drive and the disk drive door handle closed. When the disk is being accessed the red light seen the disc drive bezel is on. If the processor cannot communicate with the disc drive then a suitable error message is reported.

If you cannot boot the Micromass:

1 Check a Micromass PC system disk is in use, and not a Micromass PC DATA disk

2 Check the transit card is not in the first disk drive

3 Try another disk, in case the first disk is corrupted

4 Check that the disk drive controller slot card is fully seated, and that the ribbon cable is firmly fixed. Check the power lead and ribbon cable connects to the drive

5 Check the earth tab on the disk drive chassis is connected to the zero volts lead on the drive electronics

Whilst the system programs are being loaded, a banner page with the VG logo is seen on the screen. When all the system programs are correctly loaded, the programs initialise the RGA electronics and the screen changes to display the Command page.

If when using the cursor keys, the blue highlight box does not move and a 'beep' is not heard for each key press then either the keyboard has become disconnected, the key pad has developed a fault, or the main processor board has crashed. Re-boot the system to check the processor board, allowing a number of seconds after switching OFF, before switching ON, to permit discharge of some sensitive electronics.

At this stage, extensive tests have been carried out on the integrity of the processor board and disk drive to prove its correct operation.

When the instrument is linked to the RF generator and analyser (under suitable vacuum), from the command page, enabling emission checks a number of status lines for the RGA electronics, as follows overleaf:

EMISSION FAIL - the emission electronics have failed to stabilise

RF FAIL - the RF generator is not correctly responding

FILAMENT FAIL - filament has either gone open circuit (burnt out) or short circuit , or the wrong filament current is set for the type of filaments in use. See Section on Adjustment on how to check for this.

PRESSURE FAIL - the vacuum interlock signal is such that emission is disabled.

Once Emission is achieved, a spectrum can be generated. Proceed to analogue scan mode, and increase the gain to check for peaks. If no peaks are found on Faraday mode and the vacuum level is adequate for the SEM to be used, use the SEM option from the command page. Using the SEM, go back into analogue scan and again check for peaks.

If peaks cannot be seen using either detector, use a DVM to monitor on the "signal" test points, this is the voltage relating to peak height. If a voltage can be measured, the fault is connected with the interface card in the controller.

If the sum of all the partials does not equal the total pressure reading check the Ion energy, if that is correct then suspect analyser head contamination. Use Degas to 'clean' the source area, before removing the analyser from the vacuum system.

For split peaks, check the focus potential on the PSU slot card, also the Ion energy. Again suspect analyser head contamination and use Degas to clean the source area.

10. OPTIONS

10.1. Parallel printer

The connector on the rear of the Micromass PC for a parallel printer is a 25 way D-type plug. The cable to be used is an IBM style cable, or one with connections as shown below;

Computer		Printer
25 Way Connector		36 Way Connector
1	BROWN	1
2	RED	2
3	ORANGE	3
4	YELLOW	4
5	GREEN	5
6	BLUE	6
7	VIOLET	7
8	SLATE	8
9	WHITE	9
10	BLACK	10
11	PINK	11
12	RED/BROWN	12
13	WHITE/BLUE	13
14	NC	
15	YELLOW/RED	32
16	WHITE/RED	31
19	SCREEN	19
20	NC	
21	NC	
22	NC	
23	NC	
24	NC	
25	NC	

NC - NO CONNECTION

With this option, the special system disk will be required which has the printer software incorporated. To generate a printout of any page press the **Prt** key once.

Ensure that the printer is set to "on-line" before attempting to obtain a hard copy.

10.1.1 Technical Details for Printer

When the **Prt** key is pressed, the screen display freezes and a raster type scan is made of the screen. The pixel pattern is then sent to the printer to form a duplicate image, whilst this is taking place the mass spectrometer operation is suspended.

Any default printer support software is for an Epson FX-80 compatible. Other printer derivers are available as an option, from a range of 150 different types (including colour printers).

10.2. Serial Printer

The connector on the rear of the Micromass PC for a serial printer is a 25 way D-type socket in a slot card position.

10.3. Analogue Outputs

This option works only in the RUN mode of MIM. For the first ten channels, a voltage (0 to 10V) is fed out through SKT2, ANALOGUE I/O proportional to the reading within the decade.

eg	pressure reading	3.2×10^{-7}, voltage = 3.2V
		$1.7. \times 10^{-9}$, = 1.7V
		$9.0. \times 10^{-5}$, = 9.0V

This operation is totally transparent to the user and NO access to alter it via the key pad is available.

10.4 Plotter

Any HPGL (Hewlett Packard Graphics Language) compatible plotter can be connected to a Micromass Pc when it is ordered with the appropriate interface and software. The available interfaces are Serial - RS232, Parallel - Centronics, and IEEE-488.

For a serial plotter, the supplied nul-modem plugs into the rear of the Micromass PC, then the RS232 cable plugs between this and the plotter. The plotter will need to to be set for 9600 baud, 8 data bits, one stop bit and no parity.

Depending on the plotter model and the screen display up to eight colours can be used, such an example would be the HP Colorpro 7440A plotter for the TREND mode of MIM.

Plotter output automatically includes the actual time and date the plot was taken, ideal for archiving data in chronoligical order.

The plotter output is started by pressing the * key.

10.4.1 Technical Details for Plotter

The screen information is drawn using a number of vectors (line drawing instructions). When a plotter output is requested a duplicate set of vectors are instantaneously sent to a spooler file in the HPGL format. This spooler file will normally exist in the RAM (which is extended to 640K for this option) or on a "hard-card" if available. This means that the mass spectrometer can continue scanning without loosing data.

This spooler file is then sent to the plotter as a background task not affecting the operation of the mass spectrometer. The data transfer can only start when the plotter is set "on-line".

You can have **both** a plotter and printer attached to a Micromass PC if required. The plotter output would still be started by pressing *, and the printer would still work from the **Prt** key.

11. OFF-LINE DATA REVIEW

This facility permits a review of stored data previously saved on a data disk, on a separate PC compatible computer. The only restriction is that the PC must be fitted with an EGA (Enhanced Graphics Adaptor).

This facility permits viewing of stored data remotely from the instrument, and if the PC has a Winchester (hard disk) then this can be used as an archive or back-up device.

To review data on the PC computer place the Micromass PC system disk into the PC, and 'boot' the system, by pressing **Ctrl-Alt-Del** at the same time. Note that there are some differences between the Micromass key pad and a PC keyboard:

Micromass PC Computer	PC Computer keyboard
*	**End**
?	?
Prt	*

The built-in screen dump routine of the PC is only for CGA graphics, and will NOT work with the EGA graphics used on the Micromass PC.

A screen dump is only possible with an EGA screen dump routine or if the option is available on the Micromass PC system disk.

Optional software routines are available from the local agent or VG Quadrupoles which can re-structure the data held on a data disk from its normally compressed style to ASCII. The layout of the resulting ASCII file is in such a style as to be read in by a number of spread-sheets (eg Symphony, Lotus-123).

A second software package allows plotting of stored data from MIM against itself, and not with respect to time. A typical application is where temperature is sensed using one of the analogue inputs, and plot pressure(s) with respect to temperature.

Technical reports on both packages are available from VG Quadrupoles.

12.0 RF GENERATOR

100 AMU units

The RF Generator consists of a crystal controlled oscillator, a driver stage, an output stage, the rf amplitude, a ± constant voltage source, a unity gain differential input stage, and connections for the Total mode.

The oscillator and buffer are three CMOS gates, IC5, the oscillator comprises the crystal, R39, C38 and C39. The other two gates are parallel buffers, L3, C36, C37 and C35 together with the input impedance of the driver stage, TR5, shape the 2MHz square wave appearing on pins 1, 5 and 8, 13 to approximately a sine wave. The driver is powered from the ± 15V rails only and is decoupled by R37, C31 and R36. The voltage on the TUNE test point controls the base bias current and hence the gain of TR5 and thus the rf drive via the tuned current step-up transformer T1.

The output transistor TR6 has the output transformer primary in its emitter circuit. The output stage is decoupled by C34.

The output transformer, T2, is voltage step-up with two anti-phase secondaries. The two live ends are connected to the rods and the other two ends are connected together via C8 and C11 which pass most of the circulating rf current. It is tuned by the rod capacitance, and fine-tuned by C21.

The rf amplitude control consists of two capacative attenuators C18, C19, C20, C27, C26, C28. The attenuated rf is rectified by D11 and D12, the resultant negative voltage is fed via R11 and R12 to the virtual earth of IC3 where it is compared to the programme voltage via R32. The resultant amplified error signal is applied via R34 to the base of the driver stage, TR5 thus adjusting and correcting the output rf voltage. The small temperature-compensated negative voltage applied to the cathodes of D11 and D12 by TR2 and VR4 'Diode Offset' is to ensure linear rectification at low levels of rf.

The dc voltages applied to the earthy ends of the transformer secondaries are supplied via two rf filters C6, L2, C10 and C5, L1, C7. The positive dc (0 to +40V) is supplied by a voltage doubler C4, D2, D1 and C2 via R7. The amplifier, IC1 and TR1 is an inverting unity-gain stage which ensures that the positive dc tracks the negative dc with VR2 'Balance' adjusting out any tolerances.

The negative dc (0 to -40) is supplied by a voltage doubler C3, D8, D7 and C14 via R15. The amplifier, IC2 and TR3 is an inverting stage with a gain of 8.3. The exact output voltage is adjusted by VR3 'Resolution'. This adjusts the ratio between the rf and dc voltages.

The differential input stage, IC4 has a zero offset adjusted by VR6 'Scale' and its gain adjusted by VR5 'Mass'. These two trimmers are used to fit the spectrum to the monitor display.

When in 'Partial' mode the TTL input on Pin 6 is low and RLA de-energised. When the Total mode is selected a high TTL level is applied to Pin 6 and RLA is energised. This connects both dc inputs together and to 0V.

D4, when fed from TTL high causes the two DC generator outputs to increase to their maximum, this is for Beam OFF.

12.1 Amplifier

This consists of two stages, a current to voltage stage and a variable gain voltage amplifier.

The current amplifier (IC3) is a FET device with a very low bias current. It has two feedback resistors connected in series with a reed relay to short one of them out. Feedback is arranged with R24, R25 and TR5 to give a voltage gain of three and when TR5, switches "off" a voltage gain of one.

The voltage amplifier (IC2) has an adjustable gain in the range of X3 to X1000 with steps of X3, X10, X30 etc. One of the CMOS switches in IC1 is used to switch a capacitor (C4) in parallel with C5 on the higher current gain range to reduce the bandwidth and thus the noise.

The first stage (IC3) and the zero setting potentiometers are fed from a locally established ±12V using the two regulators Reg 1 and Reg 2.

TR4 is used as a local buffer between the Beam Off (BO) signal and the RF generator.

12.2 SEM Supply (D)

This is a programmable negative high voltage supply mounted in the remote head. When the programme is +10V an output voltage of -3,500 volts is produced, as the programme is reduced the output reduces in a linear manner towards zero. When the programme becomes less than 1.1 volts it is switched "off" and the output, after a short delay of 0.5 seconds, is shorted out by a reed delay (RLA).

The blocking oscillator (TR4) drives a step up transformer at a frequency of about 50 KHz and the secondary drives a four stage voltage multiplier (D2, D3, D4 and D5), after smoothing by R2 and C5 it produces a smooth dc output voltage. The current in the feedback resistor (R4) is compared to the current in the input resistor (R10) and the amplified error is fed to TR2 which varies the supply volts of blocking oscillator. TR1 monitors the average current to the output stage via R12 and forms the current limit for the supply.

The other half of IC1 and TR3 form a comparator, delay circuit and relay drive for the output shorting circuit with R8 setting the threshold voltage. R16 ensures the drive to the oscillator is reduced to zero in the "off" condition. REG 1 is used to improve the supply rail rejection when long cables between the remote head and control unit are used. R11 and C10 are to reduce any hum pickup in the programme leads which would otherwise modulate the output voltage. C7 and C13 are to reduce high frequency pickup on the error amplifier input stage of rf from the rf generator and voltage spikes from the output blocking oscillator.

12.3 RF Generator

200 and 300 AMU units

The RF Generator is split into 2 p.c.b.s, one being the main p.c.b. which is permanently connected to the RF generator and head amplifier chassis and the other being the output stage which is soldered direct to the chassis mounted RF output coil leads and the wiring harness.

The RF generator produces two equal amplitude a.c., R.F. voltages at 2 MHz which are in antiphase with each other and are respectively offset by equal and opposite polarity d.c. levels. The ratio of d.c. offset to a.c. amplitude remains a closely controlled constant whilst the overall amplitude is varied in direct proportion to the input program voltage. The two resulting outputs are connected one to one pair of diametrically opposed poles and the other to the other pair of diametrically opposed poles of the analyser. The resulting effect is that of varying the mass pass-band of the analyser in direct proportion to the R.F. generator input program voltage.

12.4 Operation

The operation of the R.F. generator is as follows:

The invertor at pins 10 and 12 of IC1 together with crystal X1.R2.C5 and C6 forms a 2 MHz oscillator, its output at pin 12 is used to drive two parallel output buffer inverters whose inputs are at pin 3 and pin 6. The 2 in-phase parallel square waves are filtered and mixed to an approximate sine wave at the base of TR1 by C2, C4, L1, C1 and the input impedance of TR1. The driver transistor TR1 is powered from the ± 15V rails de-coupled by R6, R3 and C3. The oscillator runs from the -15V rail and 0V (p) and is de-coupled by R6, C9, R1 and C8. The voltage on the tune test point controls the base bias current and hence the gain of TR1 and thus the R.F. drive via the tuned current step-up transformer T1. The isolated center tapped outputs of T1 at a d.c. potential of -80V provide push pull drive to the common base configured output power transistors TR1 and TR2 mounted on the output p.c.b. The outputs at the collectors of TR1 and TR2, which are connected to L1 and L2 produce 2 antiphase R.F. voltages, any d.c. offset being removed by C13 and C17. These voltages are stepped up by the two chassis mounted air cored coils which are tapped to produce correctly balanced output voltages and tuned to resonance by the dual air gap tuning capacitor.

Feedback for control of the p-p R.F. voltage level is provided at the input of error amplifier IC5. The two capacitive dividers C7, C8, C9 and C3, C4, C5 provide a percentage of the two antiphase output voltages at the two anodes of the diode value. Whenever the voltages, at either of the 2 anodes goes above 0V (set exactly by the valve offset trimpot VR2) the diodes conduct, negatively charging C3 and C7 to a mean negative voltage equal to a fixed percentage of the p-p R.F. output voltage. When the 2 antiphase signals are mixed at the node of R1 and R2 the a.c. component completely cancels out and a d.c. current proportional to the R.F. amplitude flows into the non inverting input of IC5 the level of this current and hence the p-p R.F. output level is determined by the program voltage on the program test point. As the program voltage is increased the voltage at the non inverting input of IC5 increases causing its output to go positive and produce more R.F. drive. R.F. drive continues to increase until the current flowing from the node of R1 and R2 on the output p.c.b. causes the non inverting input of IC5 to return to virtual 0V, at this point the circuit is regulating and R.F. output is directly proportional to program input. The tune test points are used to adjust for resonance of both the transformer T1 and the output coil. The nearer to resonance both these tuned circuits are, the less amount of drive voltage required from the output of IC5, hence at resonance this voltage will be at a minimum. R35 and LED 1 provide a rough indication of the tuning. When LED 1 is lit the output of IC5 is positive. Whilst under normal tuned circumstances this volt will always be negative, the LED hence indicates an untuned R.F. generator.

Program input voltage from the control unit (as described above) appears at pins 9 and 10 of SK3 of the main R.F. generator p.c.b. This is the differential common mode signal rejecting input of the unity gain input amplifier IC4. A small offset voltage is added to the input R32 via Trimpot VR6 (SCALE) and R30, R31 divider. The gain of IC4 is closely controlled by the high stability resistors R25, R32, R33 and R34 whilst immunity to high frequency transients is provided by C15 and C19. The output of IC4 is divided via VR5 (MASS) VR4 (RESOLUTION) and R20 into two output signals, one at the junction VR5 and VR4 which provides program for R.F. amplitude control and the other at the wiper of VR4 (RES) which provides program for control of the d.c. components of the output. The divider therefore provides a constant ratio between R.F. and d.c. programs which may be adjusted via VR4 (RES).

The positive and negative unregulated d.c. is derived from the R.F. outputs of TR1 and TR2 on the output p.c.b. Positive d.c. is derived via R3, R4, a.c. coupling capacitors C18 and C20 full wave bridge rectifier D1, D4, D5, D8 and referred to +15V, and smoothing capacitor C16, whilst negative d.c. is derived via R3, R4 a.c. coupling capacitors C19 and C21 fill wave bridge rectifier D2, D3, D6, D7 referred to -80V (-135V) and smoothing capacitor C14.

The regulated negative d.c. level is set by the program input voltage at the wiper VR4. This positive voltage produces a current through R18 causing the inverting input of IC12 to rise and produce a negatively going error signal at its output. This turns off TR6 via R13 and allows the collector if TR6 to be pulled negative by R26. As the collector TR6 becomes more negative the voltage across the junction of R16 and R18 is brought to rest at the virtual 0V. C10 is provided for stability.

The positive DC is derived by the same method, but in this case the error amplifier input is provided by the negative DC supply at R22. This causes the voltage at the inverting input of IC3 to go negative causing its output to go positive thus turning off the shunt regulator TR5 and allowing its collector to be pulled up by R27. As the potential at the collector of TR5 continues to rise, voltage across R21 increases moving the inverting input of IC3 positive. The circuit reaches equilibrium when the wiper of VR1 is brought to rest at 0V by adjustment VR1 the positive and negative voltages are exactly balanced.

The 2 DC offsets are applied to the RF output coils via 2, 2nd order passive low pass filters L1, C2 and L3, C21 which attenuate RF to the DC supplies. C10, C11 and C12 act as an AC earth the RF coils whilst allowing the DC offsets to be applied directly to terminals C and D of the output coils.

12.5 Digitally Controlled Head Amplifier

The head amplifier takes its output from either a Faraday collector or a semiconductor secondary emission multiplier, the latter having the ability to produce a high gain current signal before application to the amplifier input.

The amplifier is split into 2 PCBs these being the current amplifier (input stage) and the voltage amplifier (output stage). The current amplifier, operating at very low signal levels (ie 10^{-11} amps of input for 1V of output at the highest gain) is most sensitive to noise and has to be screened inside a metal case to avoid spurious hum and noise, whilst the less sensitive voltage amplifier remains accessible for adjustment of pots.

12.6 PCB1 Current Amplifier

The input from the analyser appears at a common connection between the two reed relays RLB and RLC on the current amplifier PCB1. The input PCB can be set to one of three gains. With RLA open or closed, RLB open and RLC closed. The highest gain is selected and the signal is routed to the inverting input of IC2 (a 310J operational amplifier module). IC2 has a maximum input bias current of 10^{-14} Amps.

Feedback resistor R10 ($1x10^{11}$ohms) produces a gain of 1 volt output for 10 pico Amps input (normally expressed as 10^{-11} Amps/Volt. R8, R9, C6, R7 and C5 provide low pass filtering for noise rejection. Temperature compensation is also applied to minimise offset voltages.

With RLA open, RLB closed and RLC open the input is routed to IC1 an operational amplifier. The gain is set by the feedback resistor R1 (1×10^{8} Ohms) producing a gain of 10^{-8} Amps/Volt. The cut off frequency of the amplifiers of set by R1 and C4.

12.7 PCB2 Voltage Amplifier

In addition to the voltage amplifier this PCB contains circuitry for temperature compensation of the 310J; gain select logic; relay drives; zero set facilities for 10^{-11}, 10^{-8} and 10^{-5} amps/volt current gains; and ±12V supplies used by both the voltage amp and RF generator.

The ±12V power supply is derived from the ±15V power supply on the control unit PCB. DC inputs are de-coupled by C1 and C2 and supply IC1 and IC2 which regulates to ±12V. C3 and C5 suppress high frequency transients on the supply lines.

Since it is operating at high gains, the 310J current amplifier suffers from temperature dependant shifts in output level due to variations in the input offset currents with temperature.

The temperature effects on individual 310J amplifiers is always different. Outputs may go positive or negative with increasing temperature. The output difference over a given temperature range will vary, the constant amount of zero offset independant of temperature will vary as will the 'no compensation' temperature.

Temperature compensation overcoming the above problem is applied as follows:

The current through TH1, the 310J temperature sensing thermistor increases with temperature, hence, increasing temperature causes increasing current through the chain D5, R10, D4 and R9 causing an increasing current through TR6 and decreasing current through TR7. The difference between the two current flows into R23 resulting in a voltage at TP2. IC3 is a unity gain amplifier whose input voltage between +12V and -12V set by RV2. This results in a voltage at the inverting input of IC3 equal to the voltage set by RV2. The voltage difference between TP2 and the inverting input of IC3 is equal and opposite to the voltage difference between TP1 and the inverting input. In the mid position RV3 remains at the voltage set by RV2 regardless of temperature. As RV3 wiper is moved from the mid position towards TP2, a set of compensation curves with increasing gradients in roughly direct proportion to temperature results.

Moving the pot wiper between the mid position and TP1 results in a set of curves with increasing gradients in roughly inverse proportion to temperature.

RV1 adjusts the current level through TR7 whilst the current through TR6 remains constant, thus setting the voltage at TP2 for the temperature at which no compensation is required. At this voltage there is no current difference between TR22 and TR23 and TP1 and TP2 are at the same potential set by RV2.

The compensation curve is set up to produce a maximally flat, zero offset with increasing temperature as the output of the 310J is roughly a mirror image of the temperature characteristic of the amplifier.

10^{-8} and 10^{-5} Amps/Volt current amp gains do not require temperature compensation but do require zero adjustment. These adjustments appear at the input of IC6 in the form of small dc input voltages. The 10^{-8} A/V adjustment is provided by RV4, connected to 12V and the pot chain R56 and R53 capable of producing IC6 dc input voltages between 100mV at the junction of R53 and R49. Any small difference between 10^{-8} A/V and 10^{-5} A/V zeros are compensated by RV5 and R48 which supply current to the junction of R49 and R53. RV5 is effectively switched in and out by TR11 (controlled by the gain select logic). When TR11 is switched on, nearly all the voltage is dropped by R39 and R38 causing a small voltage near zero to appear across RV5 rendering RV5 ineffective (10^{-8} zero) whilst the TR11 is switched off 10V appears across RV5 allowing the fine adjustment of the 10^{-5}A/V zero to be effective. Remote zero adjustment is provided at the junction of R49 and R53 through R50, R54 and R55.

Depending on the gain selected either RLA or RLB contacts will close allowing either IC1 or IC2 of the current amp to be inputted to IC6 whilst C7 and C8 are switched to provide noise filtering. The gain of IC6 is set at 20 by R40, R41, R49 and R53 together with input resistor R2 or R7 on the current amp pcb.

IC6 output is fed to the inverting amplifier IC7 which has an input resistance of 10K (R42) and a feedback resistance which can be switched by solid state CMOS analogue switches (5) and (6) to either 1M, 100K (1M/110K) or 10K (1M/10K) producing respective voltage gains of 100, 10 or 1. The output of IC7 is connected to the unity gain inverting output amplifier IC8 whose gain may be reduced to zero by switching from (3) and (4) open to (3) open (4) closed.

Digital inputs G0, G1 and MULT/FARADAY control the solid state analogue switches in IC4 and IC5 selecting the voltage gain of the cascade IC6, IC7 and IC8 G2 and G3 digital inputs control the relay drive transistor stages, TR1, TR2, ,TR3, TR4, TR5, TR8 and TR9 which switch the current amplifier relays RLA, RLB and RLC on the current amp pcb and RLA and RLB on the voltage amp pcb to produce the desired gain as shown in the table contained on the schematic diagram M401-7C.

12.8 Power Supply for the Secondary Emission Multiplier (SEM)

The gain of the SEM is set by the amount of voltage applied to it. This voltage is adjusted by the SEM voltage control and is variable between -600V and -3500V.

Program voltage (0-10V) to the multiplier PSU is supplied from the 10V reference through pot chain R47, Mult Program Pot and R183. SEM mode is selected by SW6/b whilst RLA2 and RLB4 contacts are arranged to prevent operation in Degas and no filament current modes.

Supplied with 0-10V analogue program input and ±15V the SEM power supply produces a 0-3500V output as follows:

Controlled by the output of the error amplifier IC16 via R10, TR4 supplies drive current to the oscillator C5, R11, R12, T1, T2 and TR3, whilst current limit protection is provided by current sense resistor R13 and TR2. Oscillating at about 80 KHz the oscillator generates an ac voltage which is controlled by the amount of drive from TR4 and is stepped up by transformer T2. The output of T2 is rectified and multiplied by the voltage multiplier C7, C8, C9, C10, D6, D7, D8 and D9. The output is de-coupled by R14 and smoothed by C11, R16 provides feedback to IC1b non-inverting

input which is balanced with respect to the inverting input at 0V by the program input through pot chain R1, R2 smoothed by C1 and fed to the inverting input of IC1b via R6. C2 and C8 control the speed of error amp response whilst D1 limits the negative voltage at the non-inverting input of IC1b.

Schmitt comparator IC1a has its hysterisis and switch level set to about 1.45V rising and 1.15 volts of falling program by R4, R5 and R7. As program volts fall below 1.15V (which only occurs in degas, no filament current or the Faraday mode) the output of the comparator saturates positive causing the inverting input of IC1b to go positive through D2. This produces a negative error signal at the output of IC1b, turning off drive to TR4 and reducing the output to zero volts after a time set by R15, R16, the load and C11. After the time constant of R9, C3 and switch level set by D5 which is longer than the time taken for the output to reduce to zero under no load conditions TR1 turns on energisers RL1, closes contacts RL1a. This shorts the output via R15 and R17 to earth ensuring no voltage at the output in Faraday, degas and no filament current modes of operation.

12.9 Pole Bias Option

An option has been made to the electronics such that an internally set Pole Bias is applied to the quadrupole rods. In order to see whether your instrument has the modification remove the RF box cover and look for a variable resistor in place of C15. The important parameters to note are:

1. The Ion Energy is now set to 7eV nominally.

2. A pole bias of +2 to 4V is applied to the quadrupole rods in RF and DC (PARTIAL pressure) mode.

3. Pole bias is not applied in RF only (TOTAL) mode.

4. The emission current levels in PARTIAL and TOTAL have not changed.

In order to measure the DC balance and Pole Bias setting the following procedure needs to be used:

a. On the RF board (MGA 401 32B) short out the PROGRAMME test pin to 0V. Adjust ΔM pot fully clockwise.

b. Measure the voltages on DC+ and DC- test pins with respect to ground. These values should be identical and give a direct reading of the applied Pole Bias. Note the value. The Pole Bias can be adjusted by the variable resistor in the position of C15.

c. In order to measure the DC balance adjust the Pole Bias until DC+ and DC- read 0V with respect to ground. Remove the link between the PROGRAMME test pin and 0V. Select maximum mass 200 or 300 amu. Adjust VR1 until DC+ and DC-are balanced.

d. Reset the POLE BIAS to its original value i.e. +2 to 3V optimising the peak shape in analog scan. Once the DC's are balanced adding the voltages on the DC+ and DC- test pins gives twice the applied Pole Bias.

13. APPENDIX A - GLOSSARY OF VACUUM TECHNOLOGY

PARTIAL PRESSURE:
is the contribution that each component gas makes to the total pressure of the system and is expressed directly in millibar, or in parts per million (ppm). The partial pressure of a gas is obtained by measuring the height of the appropriate peak on the mass spectrum.

TOTAL PRESSURE:
is the sum of the partial pressures.

MINIMUM DETECTABLE PARTIAL PRESSURE:
is the smallest component pressure that the spectrometer can detect.

MAXIMUM OPERATING PRESSURE:
is the highest total pressure at which the instrument may be safely operated.

RESOLUTION:
is a measure of the instrument's capability of separating adjacent mass peaks. For example, 10% valley resolution means that the valley between two adjacent peaks of equal height and separated by one mass unit will be 10% of the height of either of the peaks.

AMU:
Atomic Mass Unit, for example from mass position 27 to 28 is 1 amu.

SPAN:
range of scan. For example, if it is required to scan from mass 28 to 32, set start mass to 28 and use a mass window of 4 amu to give last mass of 32.

BAKEOUT:
is a technique used to obtain low background pressures and a clean vacuum system and involves raising the temperature of the system to (say) 250°C for several hours while under vacuum.

EMISSION:
is a measure of the total electron current leaving the filament. (Hence linked to sensitivity of instrument).

LOW WORK-FUNCTION FILAMENTS:
emit electrons at lower surface temperatures than the standard tungsten filaments and are used primarily where samples may be subject to thermal reaction.

IONISING CURRENT:
is the part of the emission which causes ionisation within the ion source by electron impact.

PARTS PER MILLION (PPM):
is a measure of concentration expressed as a fraction of the total pressure (taken as 10^6 parts).

BASE PEAK:
Largest peak in spectrum of a pure component.

CRACKING PATTERN:
Tabulation of relative peak heights in spectrum of a pure component. (Usually written using 100 for height of base peak).

RELATIVE SENSITIVITY:
Relative height of a base peak for particular component compared to that for reference compound (often nitrogen) at the same partial pressure.

FORELINE TRAP:
A cylinder filled with activated alumina which absorbs oil vapours typical of those generated by rotary vacuum pumps. When placed in the backing line of a diffusion pump or between a roughing pump and the vacuum system, it reduces backstreaming hydrocarbon contamination to negligible levels.

TORR:
A unit of pressure equivalent to one millimeter of mercury.

MILLIBAR (mb):
A unit of pressure. One atmosphere = 1013 millibar. This is the unit now accepted by the EEC as the standard for vacuum measurement (1 millibar = 0.75 torr).

PASCAL:
A unit of pressure equal to one Newton per square metre.

COLD TRAP:

A cylindrical vessel containing a flask filled with liquid Nitrogen, placed immediately up-stream of an oil diffusion pump. Vapours in the system and most important, oil backstreaming from the pump condense on the cold surface, thereby reducing system contamination. Effective protection against backstreaming is obtained from the cold traps without the use of liquid Nitrogen, the trap acting as an optical baffle. The surface of the flask is polished to reduce radiation losses. There are special techniques for filling cold traps.

BACKSTREAMING:

is the migration of vapours under molecular flow or near molecular flow conditions against the apparent direction of pumping or gas flow.

MOLECULAR FLOW:

is the condition of gas transport where the mean free path of the molecules is such that collisions occur with the walls of the vacuum vessel rather than between molecules. The result is that molecules can travel in the opposite direction to the bulk gas flow. Pressures when molecular flow occurs, are typically below 10^{-4} torr. There exists an indeterminate region between 10^{-2} and 10^{-4} torr where an unpredictable mixture of viscous and molecular flow occurs. Protection against backstreaming should be provided in this region where appropriate.

VISCOUS FLOW:

is the condition of gas transport where the mean free path of the molecules is such, that collisions occur between molecules rather than between a molecule and the vessel wall (except of course for molecules at the wall). The result is that all molecules travel with the bulk gas flow. Viscous flow conditions exist at pressures above 10^{-2} torr.

DIFFERENTIAL PUMPING:

is a technique whereby any part of the vacuum system is maintained at a higher pressure than another, by restricting the pumping speed for the gas from that high pressure part. For example, if gas flows into a mass spectrometer source at a given rate Q and the pumping speed from the source is S then the pressure in the source.

$$Ps = \frac{Q}{S}$$

If the gas then flows through an analyser region where a lower pressure is required to be maintained to minimise ion-molecule collisions and the pumping speed from that region is 10_S then the pressure PA will be

$$\frac{PA}{\overline{10_S}} = \frac{Q}{\overline{10}} = \frac{P_S}{}$$

thus providing a pressure differential between the two regions of 1 : 10.

Several stages of differential pumping may be used in some cases.

ION:
is an atom or molecule which is charged. This charge may result from one or more of the electrons being stripped from the neutral atom of molecule (the usual result of electron bombardment) in which case the net charge is positive; or it may result from the capture of an electron by the atom or molecule resulting in a net negative charge. The latter process (about 1 in 10^4 ions produced are negative) except for a number of molecules which have a high affinity for electrons (e.g. Chlorine).

14. APPENDIX B - MICROMASS PC SPECIFICATION

QUADRUPOLE ANALYSER

ION SOURCE:

STANDARD OR UHV:
Electron impact radially symmetric

FILAMENT:
Easy change twin filament assembly. Tungsten, thoriated iridium or rhenium filament material available

EMISSION CURRENT:
100 amu units, partial 1.45 mA, total 200mA
200 amu units, partial 1.50 mA, total 300mA

ELECTRON ENERGY:
65 eV

SENSITIVITY:
$5x10^{-4}$ A mb^{-1} using Faraday for 200 amu instruments, $3x10^{-4}$ A mb^{-1} for 100 amu instruments.

DEGAS:
Electron bombardment ramped from 2 to 8W following a programmable profile to prevent excessive outgassing

MASS FILTER:

SIZE
50 mm long rods (100-HP) or 125 mm long rods, 6.3 mm diameter

MATERIAL:
Stainless steel and ceramic.
Copper connecting wires, or tantalum for reactive environment

RESOLUTION:
Better than 10% valley over the entire mass range.

DETECTOR:

TYPE:
Faraday cup or dual Faraday/Channel Electron Multiplier
Minimum detectable partial pressure; $2x10^{-11}$ mb (Faraday)
$5x10^{-14}$ mb (Multiplier)

SEM VOLTAGE:
600V to 3kV variable

MAXIMUM OPERATING PRESSURE:
10^{-3} mb (100-HP)
10^{-4} mb (Faraday)
10^{-6} mb (Multiplier)

BAKEOUT TEMPERATURE:
300°C (analyser only)

WEIGHT:
650 g (100F-HP)
810 g (100F-LF)
900 g (100D/ 200D/ 300D)

RF HEAD:

Mass range
1-100, 1-200, 1-300 amu linear scale with equal mass width

RF FREQUENCY:
2MHz

RF AMPLITUDE:
880 V pp @ 200 amu and 440 V pp @ 100 amu

WEIGHT:
100 amu - 1.9Kg, 200/300 amu - 3.6 Kg

CONTROL UNIT:

POWER REQUIREMENTS:
100, 110, 120, 200, 220, 240 V AC
50 - 60 Hz
250 VA max

OPERATING TEMPERATURE:
15°C to 35°C

RELATIVE HUMIDITY:
90% non-condensing maximum

DISPLAY:
10" Colour CRT 640 x 200 pixels

KEYPAD:
20 keys membrane action

CLOCK:
Battery Backed Integral real time clock and calendar

PROCESSOR:
NEC V20 or 8088 running at 10 MHz

MEMORY:
512 K RAM . Expandable to 640K

DISK DRIVE:
720K byte 3.5" floppy disk

EXTERNAL CONNECTIONS:
Alarm relays (2) rated at 240V, 1A
Chart recorder output
Remote video connector
External disk drive
Vacuum Interlock

MOUNTING:
19" rack mounting, 5U high
Bench mounting with tilt feet

WEIGHT:
22 Kg

OPTIONS

ANALOGUE OUTPUTS (10)
0 to 10 V programmable to follow any signal variation of any mass peak.
Two high resolution outputs (2.5 mV per step) plus eight 8-bit DACs (40 mV per step)

ANALOGUE INPUTS (2)
0 to 10 V from external equipment. Data recorded and displayed in a similar manner to mass spectral data.

INTERFACES
RS232C or IEEE48 for bi-directional communications with host computer.

PRINTER
Epson or Okidata. Others on application

PLOTTER
Hewlett Packard or HPGL compatible

MULTIPLEXER (MP8X)
Control up to 8 analyser heads from single programmable control unit. Linking of MP8X units allows unlimited number of analysis points.

15. APPENDIX C - GENERAL PRINCIPLES OF OPERATION

The Micromass PC analyser comprises three sections: the ion source, the quadrupole analyser and the ion detector.

The construction materials are type EN38E(316) stainless steel, alumina ceramic and thoria filament with Nilo-K filament support wires, and copper filament leads.

THE ION SOURCE

Gas atoms or molecules present in the source are subjected to bombardment by electrons generated from a hot wire filament which have been accelerated by the potential difference between the filament with its cylindrical Electron Repeller held at - 70V with respect to ground and the cylindrical Source Cage held at approximately +4V with respect to ground. The filament current is normally 2.0A and that level is feedback controlled to give a constant filament to source cage current of 1.45mA.

The nominally 70 volt electrons, strip an electron from the neutral atom or molecule thus leaving it positively charged (charge=+e). In some cases, two electrons may be stripped off the neutral leaving it 'doubly charged' (charge=+2e).

The positive ions, formed at the cage potential of approximately 4V are extracted from the source and injected into the analyser by a potential of approximately - 110V applied to the Focus electrode.

THE QUADRUPOLE ANALYSER

The analyser comprises four accurately ground stainless steel rods aligned to fine limits in an alumina collar. Opposite pairs of rods are electrically connected and to each pair is applied a combination of RF and dc voltages, the phase and sign of the potentials being opposite for the two pairs of rods.

An ion entering the electric field generated by this system undergoes oscillations in a trajectory which is either stable or unstable depending upon the voltages (both RF and dc) applied to the rods and the mass of the particular ion being considered. A stable trajectory is defined as one where the path of the ion remains wholly within the physical constraint of the analyser so that the ion reaches the collector; an ion on an unstable trajectory will collide with one of the electrodes or the analyser

housing and be neutralised and therefore will not reach the collector. The ability of the mass filter to differentiate between masses is called the resolution of instrument and is determined by the ratio between the RF and dc voltage amplitudes. If that ratio is kept constant while the amplitude of the voltages is increased linearly with time, then the mass spectrometer is tuned sequentially and linearly with time to adjacent masses with increasing mass number (that is 1,2,3 100) and the resolution of the instrument remains constant over the whole scanned range.

This process is called a mass scan and the read-out of peaks thus obtained is called a mass spectrum.

The resolution of Micromass PC is such that adjacent peaks of equal amplitude are separated by a valley of at most 10% of their height. If the dc component is switched off the resolution of the filter is reduced to zero and all masses are transmitted to the collector thus giving a measure of the total pressure of the system.

THE FARADAY COLLECTOR

The Micromass PC collector is a Faraday plate screened from the source and filter supply leads by an earthed shield. A further electrode which is kept at - 110V is mounted immediately above the Faraday plate and its shield, and acts both as an electron shield, preventing electrons from the filament from reaching the collector, and as a secondary electron suppressor ensuring that any electrons generated by ions arriving at the collector are returned to it so eliminating possible errors in ion current measurement.

THE SEM COLLECTOR

This is a multiplier mounted off-axis so that neutrals and photons from the hot filament are not detected. The output electrons are collected and conducted through the central pin of the vacuum feedthrough and finally to the amplifier. The multiplier is air stable and provided the output current is kept low and it is not operated above 10^{-5} torr it has a long life expectancy.

Further information on Quadrupole theory is available on Technical Information Sheet 02.439.

16. APPENDIX D - RELATIVE SENSITIVITY FACTORS FOR 5" FILTER QUADRUPOLE ANALYSERS

To arrive at a relative sensitivity factor for a given gas the user needs to know the ionisation efficiency relative to nitrogen, the transmission of the quadrupole filter relative to nitrogen (measured in Faraday mode to eliminate mass discrimination effects in the multiplier) and the gain of the multiplier (if in operation) relative to the gain for nitrogen (it is usual to calibrate the multiplier with nitrogen (m/e = 28) at a gain of 10^4).

The relative sensitivity factor Srel can be calculated as follows:-

Srel = I x T x G

where I = relative ionisation efficiency
T = relative transmission factor
G = relative gain in multiplier mode

Obviously in Faraday:

Srel = I x T

The value for I can be approximated from Fig 1, which shows National Physical Laboratory data for ionisation efficiencies for different gases. The value for I can be approximated by:-

I = 0.0491 Ne + 0.207

Where Ne is the number of electrons per molecule of the gas.

T, the relative transmission factor can be seen in Fig 2. These data were partly accumulated recently and partly from analysis of test data. The data for high masses ie 28 has been collected from over 35 analysers. Fewer have been used for the low mass data. The shaded region covers the spread of sensitivity of our analysers, the worst errors occurring at minimum and maximum mass. Even so, at mass 200 there is only a spread of a factor of 5, which is not that unreasonable taking the manufacturing tolerances etc, into account. At mass 2 the spread factor is 2.5. A value for T can therefore be read from this graph with an idea of the error that can be associated with it. For more accurate work the individual user needs to calibrate the mass discrimination of the filter by measuring

the peak height of a gas with a known cracking pattern. Note also, that the data given are for mass resolution of 1 amu with 10% maximum valley between peaks. If this criterion is not met then the transmission of the filter will vary, particularly at high and low mass.

G, the relative gain is measured by comparing the peak heights on complimentary Faraday and Multiplier spectra over the range 1-200 amu. A set of results can be seen in Fig.3. The data does not fit a simple M- function but a smooth curve has been drawn through the data. This data can be used to obtain a value of G.

For example, to calculate a value of Srel for Xenon (mass = 131, atomic no = 54):-

Ixe = 0.0491 x 54 + 0.207 = 2.86

Txe = 0.08 to 0.28

Gxe = 0.22

Sxe = 0.05 to 0.18

Sxe = 0.12-0.06

Hence a value of 0.12 can be used as a reasonable approximation. A peak measured at mass 131 must be divided by 0.12 to correct the peak height.

IONISATION EFFICIENCY RELATIVE TO NITROGEN

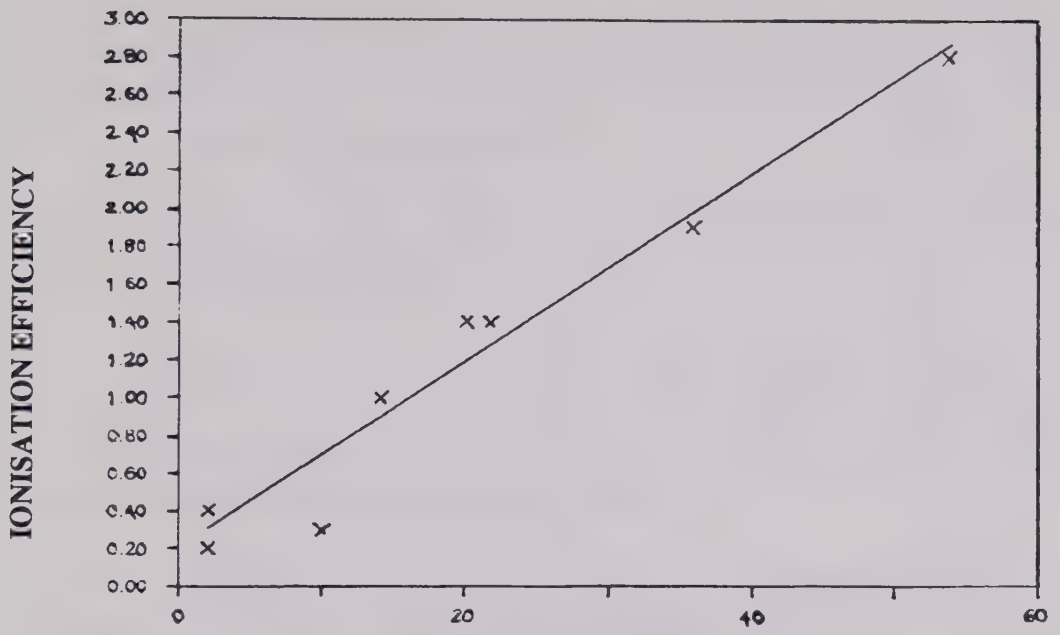


FIGURE 1

QUADRUPOLE TRANSMISSION 5" FILTER DATA RELATIVE TO MASS 28 (NITROGEN)

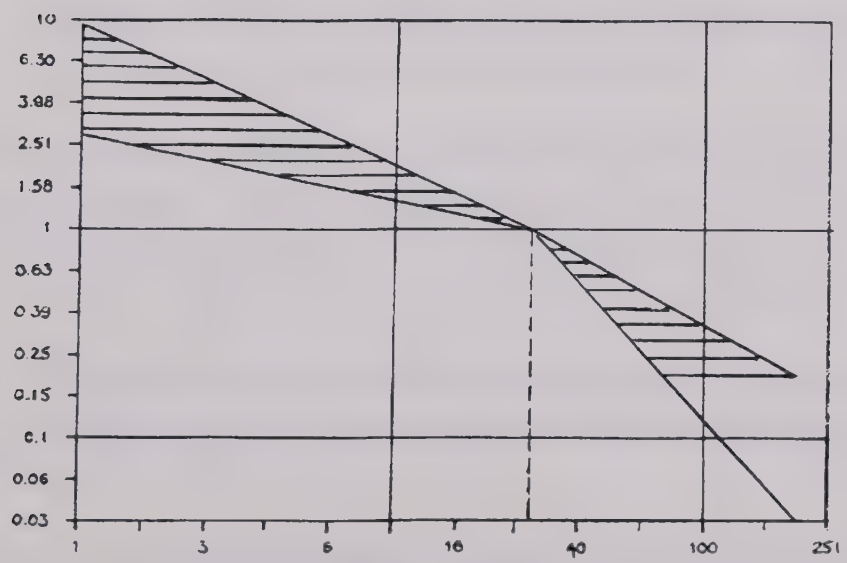
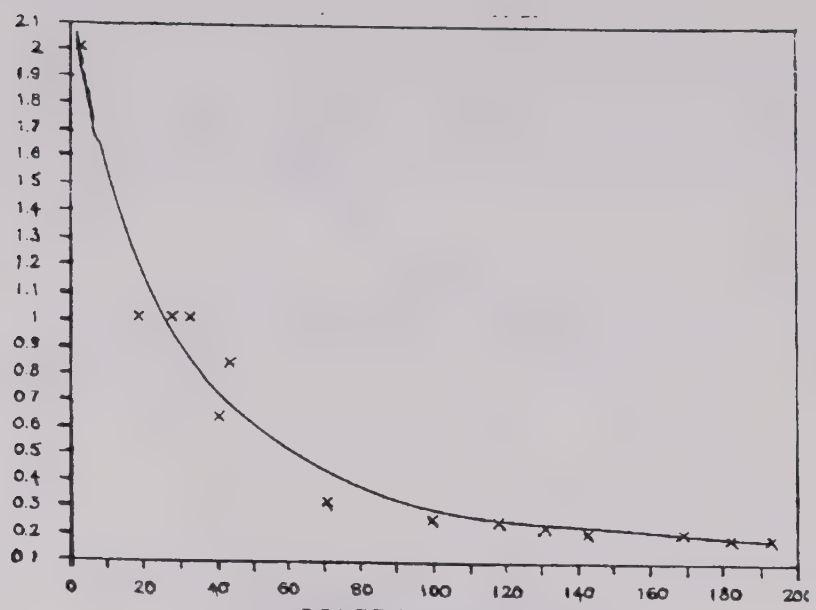


FIGURE 2

QUADRUPOLE TRANSMISSION 5" FILTER DATA
RELATIVE TO MASS 28 (NITROGEN)



MASS (a.m.u)

FIGURE 2

17. APPENDIX E - AUTOMATIC LIBRARY SEARCH

The MICROMASS PC software offers fully automatic cracking pattern library search, to assist the user in finding the composition of his measured spectrum assuming the histogram scan is made up from linear configuration of component gases.

If the cracking patterns of these components are known the contribution of each gas can be determined by solving simultaneous equation.

If the component gases making up the scan are not known, it is possible, in principle, to solve by full matrix inversion the linear equations for every cracking pattern in the gas database. There can be 200 gases in the database, and in general only a few significant masses in the cracking pattern providing too many unknowns and not enough equations.

The method used is to try small groups of gases. Ideally, with unlimited computing power all combinations of say ten gases, could be tried. If the best match of all these was found, this is the best solution. The drawback is that this would take several tens of thousands of years to compute.

In practice, therefore, all unlikely patterns must be excluded before trying to solve. A list is made up of the twenty biggest products of the primary peak in the cracking patterns and the intensity of the normalised histogram data at the relevant mass. Only cracking patterns where the secondary and tertiary peaks are present in the histogram data are included in the list.

When the linear equations are solved by matrix inversion there are usually some negative solutions; this is mathematically correct. The pattern with the most negative solution is removed from the list, and the remaining patterns are solved again. This repetitive iteration continues until there are no more negative (or close-to-zero) solutions. The remaining patterns are the probable best fit.

Sometimes, the problem of very similar patterns can cause valid patterns to be rejected. Group together gases which are likely to be in the system, using the group number facility. The search can then be performed on these patterns only.

Overall, search times can vary from seconds to minutes depending on the complexity of the data, and the speed of the host computer. Dots on the screen indicate the progress of the search.

Accuracy is quite reasonable, considering the accuracy of the patterns themselves. Different display modes for the results include: 'tabular', where the ratios are displayed; 'merged' and 'twoplots', where the histogram data is displayed together with a 'composite' spectrum made up to the computers best fit of patterns, and 'subtract', where the data is subtracted from the composite.

The search routines can be used both on live data from the histogram mode, and with data previously stored on disk. Any given spectrum can be automatically made into a stored cracking pattern.

To assure better and more accurate matching use the 'averaging' mode in histogram mode, so that as little noise as possible is present on the data used for the search. This will assure better and more accurate matching.

18. APPENDIX F - REMOTE OPERATION

CONTENTS

1.	INTRODUCTION	100
1.1	Communications Protocol	100
1.2	Commands and Responses	100
1.3	Parameter Classes	101
1.3.1	Scalars	101
1.3.2	Arrays of Scalars	102
1.3.3	Structures	103
1.3.4	Arrays of Structures	103
2.	GETTING STARTED	105
2.1	Remote Operation	105
2.2	Error Messages	106
3.	USING MIM MODE REMOTELY	107
3.1	Cycle Times, Pre-locking etc	107
3.2	Setting a Recipe	108
3.3	Running MIM	111
4.	REMOTE SCAN MODE ACCESS	112
4.1	Scan definition structure	112
4.2	Getting Scan Information.	113
4.2.1	Scan preamble structure	113
4.2.2	Scan values	114
5.	REMOTE HISTOGRAM MASS ALIGNMENT	115
5.1	Scan definition structure	115
6.	SETTING COMMAND PAGE VARIABLES	116
6.1	Emission and filament	116
6.2	SEM	117
6.3	Parameter Access Modes	118

Appendix I 120
Appendix II 122
Appendix III 123
Appendix IV 125
Appendix V 126

1. INTRODUCTION

The purpose of this option is to enable a host computer or serial terminal to remotely control the mass spectrometer i.e. to set mass spectrometer parameters and acquire data.

The distance between the mass spectrometer and the host computer can be up to 30 m, for 9600 baud. This can be extended to many kilometers by using a fibre optic hardware option - this may also be useful in particularly noisy environments.

1.1 Communications Protocol

The communications protocol is referred to as VG CP (VG Communications Protocol).

Remote communications between host computer and the mass spectrometer can be likened to a conversation between two people. Like all good dialogue it is best if only one person speaks at any one time. The initiator of the dialogue obtains a response from the other participant and so on. The host computer **always initiates** dialogue by sending a command, the mass spectrometer **always replies** with a response.

1.2 Commands and Responses

Commands and responses are composed of ASCII alphanumeric character fields separated by a semi-colon (;) and terminated by line-feed and carriage return (**<lf> <cr>**). Note that characters within a field are case sensitive - **P** does not have the same meaning as **p**

;	Field separator
<lf>	Line-feed character i.e. Ctrl J
<cr>	Carriage return character i.e. Ctrl M

The first field value of all commands and responses, usually a single ASCII character,refers to a command/response type (CR type) which may or may not have additional fields. A list of command/response types is given in appendix I.

Example:-

Host:	**O;1<lf><cr>**	Commence MIM run
MS:	**OK<lf><cr>**	Data accepted
Host:	**T<lf><cr>**	Terminate run i.e.stop MIM run
MS:	**RUN TERMINATED<lf><cr>**	

1.3 Parameter Classes

There are four types of parameter class under VG CP. These are scalars, arrays of scalars, structures and arrays of structures.

1.3.1 Scalars

A scalar is a single alphanumeric entity and can be either a:-

Single letter or group of letters, e.g. Y, Methane

Integer number, e.g. 28, 4

Floating point numbers, e.g. 1.32, 4.01 E-7

They refer to either a parameter code or a parameter value and are requested, set and returned by command types. The general command/response is of the form:-

<CR type>;[<Parameter code>[;<Parameter value>]]<lf><cr>

A list of parameter codes is given in appendix II.

Example:-

Host:	**P;80;30<lf><cr>**	Set parameter code 80 to parameter value 30, i.e. MIM cycles = 30
MS:	**OK<lf><cr>**	Data accepted

1.3.2 Arrays of Scalars

This parameter class denotes a number of identical scalar types e.g. integer numbers.

The general command, response form is

<CR type>;<Parameter code>;<Parameter value 1>;<Parameter value 2>; <Parameter value n><lf><cr>

Note: A single parameter code denotes the parameter type for the whole array.

Sometimes the array message may exceed the maximum message length (128 characters). To overcome this the message is broken down into a number of segments. The response message from a get array of scalars command may take the form

P;<Parameter code>;<Parameter value 1>; ... <lf><cr>
P;<Parameter code>;<Parameter value n>; ... <lf><cr>

P;<Parameter code>;<Parameter value r>; ... <lf><cr>
Q;<Parameter code>;<Parameter value n; .. . <lf><cr>

CR type **P** denotes that the data is incomplete whereas **Q** indicates that it is complete. When the whole array message is short (for example when acquiring a histogram scan over a small mass range) just the **Q** CR type appears. Similarly when setting large arrays CR types **'** and **a** are used to indicate not complete and complete respectively.

1.3.3 Structures

This parameter class denotes a mixture of different scalar types e.g. integer numbers and floating point numbers. The general form of the command/response is:-

<CR type>;<Parameter code>; <Structure parameter code>;<Structure value>; <Structure parameter code>; <Structure value><lf><cr>

Note: The structure parameter code and its parameter values are sent in pairs thus allowing structures to be sent in any order unlike arrays of scalars which are position dependant.

Example:-

Host:	**@;151<lf><cr>**	Get parameter value for parameter code 151 i.e. get MIM data
MS:	**^;1;1.99F-7;2;4.07F-8;17;3;18;300<lf><cr>**	

Valid request returning complete structure for parameter code 151 (MIM data)

Refer to Section 3 to decode this structure.

As with arrays of scalars, structure messages may be broken down into segments using the CR types p,q,', and ∧. (See Appendix I for details).

1.3.4 Arrays of Structures

This parameter class denotes an array of identical structures e.g. entries in a MIM recipe.

The general command/response is of the form:

<CR type>;<Parameter code>; <Structure 1>;<Structure n><lf><cr>

Structure n has the form

<Structure parameter code>; < Structure value>; <Structure parameter code>; <Structure value>

Note: That the structures within the array are order dependent.

Example:-

Host:s;10;1;1;2;Y;3;F;4;28;5;Nitrogen;6;2;7;A;8;07;9;1.00;10;N<lf><cr>

MS: **OK** <lf><cr>

Set array of structures, array incomplete, for parameter code 10,
i.e. set an entry in the MIM recipe.

Again messages can be broken down using the CR types **b**, **c**, **d**, **r**, **s** and **t**.

2. GETTING STARTED

The power up RS232 configuration of the mass spectrometer is set to 9600 baud, eight data bits, no parity and one stop bit. The host computer or serial terminal, should be set accordingly. Appendix III gives the pin out details of the RS232 port.

If for some reason the host computers RS232 cannot be set to these conditions then the Micromass/Spectralab configuration can be altered as described in Appendix IV.

2.1 Remote Operation

To establish the communications link use the pin-pin ribbon cable and null-modem supplied to link between the serial port (COM1) of the mass spectrometer and the RS232 port of the host computer or serial terminal. Start the mass spectrometer in the normal way.

Invoke remote operation by selecting the remote option from the appropriate Micromass Or Spectralab Menu.

Communications should have now been established and the mass spectrometer will wait for a command. If communications are not established correctly check that the host computer is set to the correct baud rate etc and that the RS232 wiring is correct.

Example:-

Host:	**P;82;Y<lf><cr>**	Set parameter code 82 to Y select pre-locking in MIM
MS:	**OK<lf><cr>**	Data accepted

To exit from remote operation the **X** parameter code is used, the computer will revert to the menu

Example:-

Host: **X<lf><cr>** Exit Remote Control

MS: **(there is no reply)**

2.2 Error Messages

On receiving an incorrect command the mass spectrometer replies with one, or more, error messages as shown in the example below.

Host: **p<lf><cr>** i.e. an incorrect command type

MS: **ERROR;UNKNOWN COMMAND <lf><cr>**

Host: **0;<lf><cr>** i.e. the parameter code had been omitted

MS: **ERROR;PARAMETER CODE FORMAT <lf><cr>**

Host: **P;82;34 <lf><cr>** i.e. incorrect parameter value

MS: **ERROR;PARAMETER SHOULD BE Y OR N <lf><cr>**

Host: **s;10;1;1;2;Y;3;N;4;28<lf><cr>** i.e. an incorrect parameter value for structure parameter code 3

MS: **ERROR;10;3;PARAMETER SHOULD BE M, F OR U <lf><cr>**

3. USING MIM MODE REMOTELY

In MIM mode the host computer or serial terminal can:-

Set cycle times, pre-locking etc
Set up the recipe
Run MIM and receive data
Set alarm limits

3.1 Cycle Times, Pre-locking etc

Parameter code 80 sets up the number of cycles MIM will run for.

Example:-

Host:	**P;80;30 <lf><cr>**	Set 30 cycles limit
MS:	**OK<lf><cr>**	Data accepted

The time period between cycles can be set using parameter code 83. The mass spectrometer measures time in units of 0.1 seconds. Thus to set a 5 second time period between cycles we need to specify 50 mass spectrometer time units.

Example:-

Host:	**P;83;50<lf><cr>**	Set time period to 5 secs
MS:	**OK<lf><cr>**	Data accepted

Pre-peak locking, refer to mass spectrometer manual for an explanation of this term, is set using parameter code **82.**

Example:-

Host:	**P;82;N<lf><cr>**	No pre-locking
MS:	**OK<lf><cr>**	Data accepted

Pre zeroing, refer to mass spectrometer manual for an explanation, is set using parameter code 85.

Host:	**P;85;Y<lf><cr>**	Enable Pre Zeroing
MS:	**OK<lf><cr>**	Data accepted

Alarm checking, refer to mass spectrometer manual for an explanation, is set using parameter code 84

HOST:	**P;84;N <lf><cr>**	Disable Alarms
MS:	**OK<lf><cr>**	Data accepted

Alarm units, refer to mass spectrometer manual for an explanation, are selected to parameter code 86

HOST:	**P;86;Y <lf><cr>**	Alarm values in partial pressure units
MS:	**OK<lf><cr>**	Data accepted
HOST:	**P;86;N <lf><cr>**	Alarm values in percent
MS:	**OK <lf><cr>**	Data accepted

3.2 Setting a Recipe

The MIM mode recipe is set using parameter code 10 - an array of structures. Each structure represents a single channel in the MIM recipe. Table 1 shows how each structure is composed.

Example:-

Host:	**s;10;1;1;2;Y;3;F;4;28;5;Nitrogen;6;2;7;A;8;7;9;1.00;10;N;11;0.0e-10;12;9.999e-5<lf><cr>**
MS:	**OK<lf><cr>**

Set channel 1 to measure Nitrogen using the Faraday detector with auto-ranging, no storage required. Note the array of structures is incomplete, as indicated by the **s** command type.

Example:-

Host: **t;10;1;4;2;Y;3;M;4;40;5;Argon;6;2;7;A;8; 9;9;1.00;10;N; 11;0.0;12;5.4e-5<lf><cr>**

MS: **OK<lf><cr>**

Set channel 4 to Argon using the multiplier detector with fixed gain M-9, no storage required. Note the array of structures is complete, i.e. the whole recipe is complete, as indicated by the **t** command type.

Structure Parameter Code	Item	Type	Example	Limits
1	Channel Number	numeric	01	1-16
2	Channel Enabled	alpha	Y	Y or N
3	Detector Type	alpha	F	F, M or U
4	Mass	numeric	104	0-999
5	Name	alphanumeric	10	Methane
6	Accuracy Code	numeric	2	1,2,3 or 4
7	Autoranging	alpha	A	A or C
8	Gain Range	numeric	7	5-13
9	Relative Sensitivity	numeric	1.02	0.01-100.00
10	Store	NOT USED remotely		
11	Low Alarm	numeric	1.7e-7	0.0-9.99e-5 or 0.0-100.0
12	High Alarm	numeric	27.34	0.0-9.99e-5 or 0.0-100.0

TABLE 1

MIM Recipe, Array of Structures, Parameter Code 10

(Setable Only)

Footnote: The limits on low/high alarms depends on the alarmode selected.

3.3 Running MIM

Once all the relevant parameters have been set MIM mode is run using parameter code O.

Example:-

Host:	**O;1<lf><cr>**	Run MIM
MS:	**OK<lf><cr>**	Data accepted

To acquire data from the computer the parameter code @ is used.

Example:-

Host:	**@;151<lf><cr>**	Request MIM data
MS:	**^;151;1;1.99F-7;2;4.07F-8;17;3;18;300<lf><cr>**	

The data returned is in the form of a structure. Structure parameter codes 1-16 refer to channel numbers - the structure parameter value is the partial pressure associated with that channel.

Structure parameter code 17 gives the cycle number and structure parameter code 18 gives the time in one tenth second units from the start of a run. This number ranges from 0 to 864000 (24 x 60 x 60 x 10). So in the above example the data is for cycle number 3 and was taken 30 secs into the run.

To terminate the run parameter code T is used.

Example:-

Host:	**T<lf><cr>**	Terminate run
MS:	**RUN TERMINATED<lf><cr>**	

4. REMOTE SCAN MODE ACCESS

All of the scan modes may be controlled remotely - analogue scan; histogram scan and logarithmic histogram scan.

4.1 Scan definition structure

The scan parameters are defined by structure number 131. Details of the structure members are given in Table 2.

Structure Parameter Code	Item	Type	Example	Limits
1	Detector Type	alpha	F	F or M
2	Start gain	numeric	7	5-10 (Faraday) 7-13 (Sem)
3	End gain	numeric	6	5-10 (Faraday) 7-13 (Sem)
4	Start mass amu	numeric	01	0-maximum mass
5	End mass amu	numeric	200	0-maximum mass
6	Averaging	numeric	300	1-4096

TABLE 2

Scan Parameter Structure Code 131 (Setable only)

Note that the End gain is only used for logarithmic scan, also the averaging is only used by analogue and histogram scan.

4.2 Getting Scan Information.

Scan information is sent back in two segments. The first segment is a structure (code 156) defining the scan parameters (time etc.). The second segment is the body of the scan values; this is sent as an array of scalars. The array of scalars is sent back in segments (using the P and Q first field identifiers). This is done to limit the message length to 128 characters.

Overleaf flow chart 1 demonstrates how to obtain an analogue scan.

4.2.1 Scan preamble structure

Table 3 shows the scan preamble structure.

Structure Parameter Code	Item	Type	Example	Limits
1	Scan Time in 1/10 seconds	numeric	3000	0-864000
2	Start mass	numeric	10	0-maximum mass
3	End mass	numeric	200	0-maximum mass
4	Status OK	alpha	Y	Y or N

TABLE 3

Scan preamble structure 156 (Readable Only)

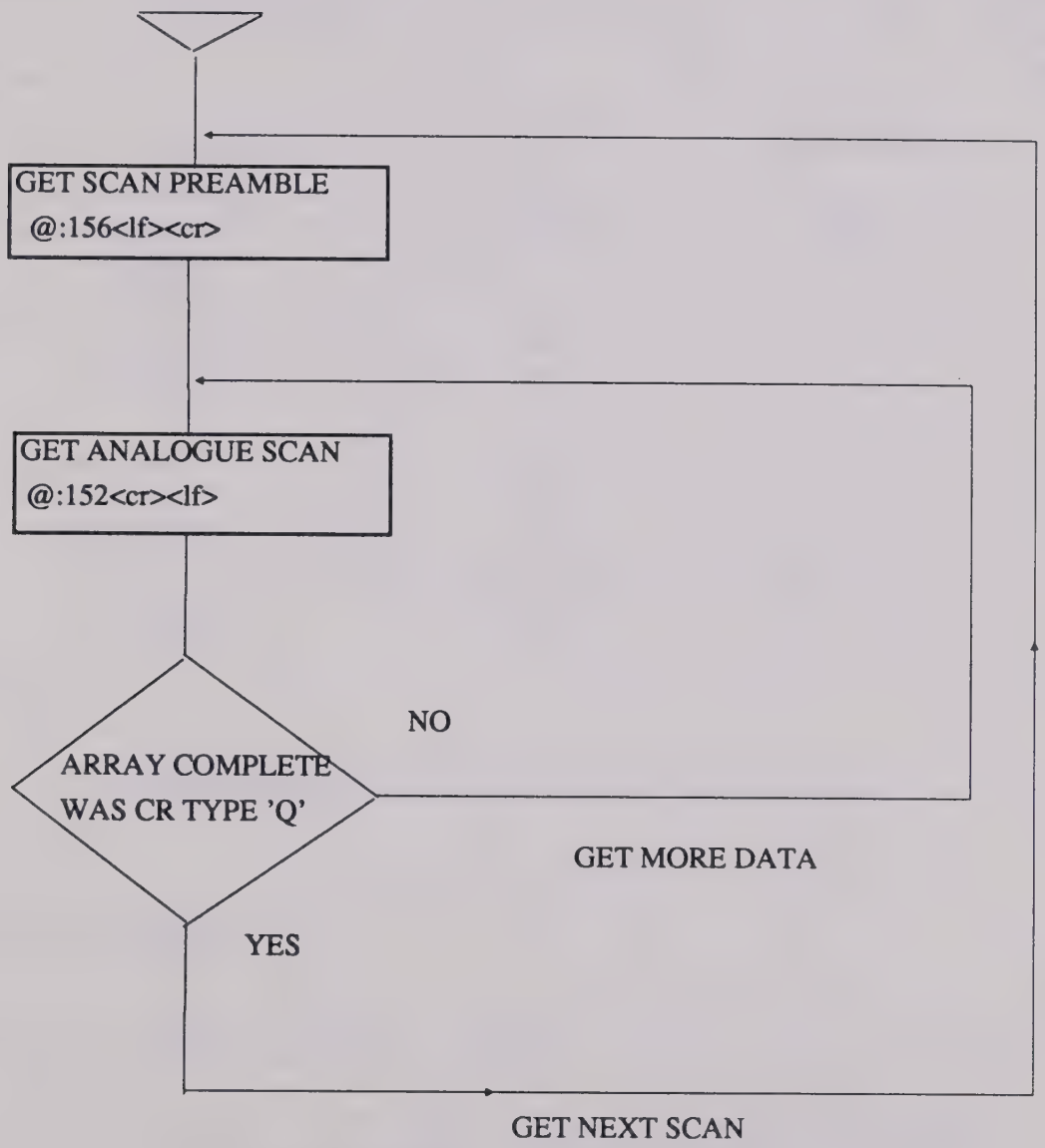
typical response is: **∧;156;1;100;2;4;3;189;4;Y <lf><cr>**
indicates a time of 10 seconds, start mass of 4, end mass of 189 and status OK.

4.2.2 Scan values

Scan values are sent back in VG signal value format, best demonstrated by the following example.

P;153;1.1F-10;2.3F-10;7.0F-7<lf><cr>

Note that for analogue and histogram scan the gain values will be the same for all readings.



Flow Chart 1 - getting scan data

5. REMOTE mass alignment

5.1 Scan definition structure

The mass alignment parameters are defined by structure number 130. Details of the structure members are given in Table 4.

Structure Parameter Code	Item	Type	Example	Limits
1	Detector Type	alpha	F	F or M
2	Start gain	numeric	6	5-10 (Faraday) 7-13 (Sem)
3	End gain	numeric	7	5-10 (Faraday) 7-13 (Sem)
4	Start mass amu	numeric	01	0-maximum mass
5	End mass amu	numeric	200	0-maximum mass
6	Search Mode	alpha	I	E (Existing) I (Ideal)

TABLE 4

Histogram Mass Alignment Parameter Structure Code 130 (Setable only)

6. SETTING COMMAND PAGE VARIABLES

6.1 Emission and filament

Command page variables (except SEM) can be set from the command page structure (number 132).

Table 5 shows the structure items.

Structure Parameter Code	Item	Type	Example	Limits
1	Emission	alpha	Y	Y or N
2	Filament	numeric	1	1 or 2

TABLE 5

Command page structure parameter code 132 (setable only)

eg: **q;132;1;Y;2;1<lf><cr>**

turns emission on and selects filament 1.

6.2 SEM

SEM values are set from the SEM structure (number 110).

Table 6 Shows the structure items.

Structure Parameter Code	Item	Type	Example	Limits
1	SEM ON	alpha	Y	Y or N
2	Volts	numeric	1200	600-3500
3	Calibration mass	numeric	28	0-maximum mass
4	Calibrate	alpha	Y	Y or N

TABLE 6

SEM structure parameter code 110 (Setable only)

eg : q; 110; 1;Y;2;1500;4;N <lf><cr>

turns SEM on at 1500 volts with no auto calibrate

6.3 PARAMETER ACCESS MODES

Parameter access modes affect the data format. At the moment access formats can be changed for the following parameters.

151	Acquire	MIM Data
152	Acquire	Analogue Scan Data
153	Acquire	Histogram Scan Data
154	Acquire	Log Histogram Scan Data
156	Acquire	Scan Preamble

There are two access modes available

Access Mode 1 - Transmit data without checksum

Access Mode 2 - Transmit data with checksum appended

To set Log Histogram Scan Data to checksum access mode:-

R;154;2 <lf><cr>

Parameter access modes can be acquired using the S CR type. For example after the above command

S;154 <lf><cr>

Produces the response

I;151;2 <cr><lf>

Indicating that MIM data will have a checksum appended

Checksums are evaluated as follows:-

All ASCII values of the message (excluding the <lf><cr> are summed. 64 decimal is added to the sum modulo 64.

eg Checksum = 64 + (Σ ASCII CODES % 64)
where % represents the modulo operator eg 125 % 64 = 61

For host computers that do not have a modulo arithmetic operator modulo 64 can be achieved by anding the sum of ASCII codes with hexadecimal 3F.

eg Checksum = 64 + (Σ ASCII CODES 'AND ' HEX3F)

The checksum is the last message character before the <lf><cr>.

If the host machine detects a checksum error then there is no mechanism for re-accessing the data - the data is best discarded.

All access modes are defaulted to 1 on power up.

APPENDIX I

VG CP Command/Response Types

Commands	ASCII characters	Example
Commence Run	O	0;1<lf><cr> go MIM
Halt Run	T	T<lf><cr>
Exit Remote Operation	X	X<lf><cr>
Get Parameter	@	@;156<lf><cr> get scan preamble
Set Scalar	P	P;80;27<lf><cr> set MIM CYCLES to 27
Set Array of Scalars Array Incomplete	,	Currently not used
Set Array of Scalars Array Complete	a	Currently not used
Set Structure Structure Incomplete	p	P;110;1;7;2;1500<lf><cr>SEM- on 1500 volts
Set Structure Structure Complete	q	q;110;3;40;4;7<lf><cr>SEM calibrate at mass 40 amu
Set of Array of Structures Structure Incomplete	r	r;10;1;3;6;3<lf><cr> MIM channel 3 accuracy code to 3
Set Array of Structures Structure Complete	s	s;10;1;3;12;7.4e-7 MIM channel 3 high alarm limit to 7.4e-7
Set Array of Structures Array and Structure Array	t	t;10;1;16;12;7.4e-7 MIM channel 16 high alarm limit to 7.4e-7
Set Parameter Access Mode	R	R;154;2 <lf><cr>set checksum on for log hist data
Get Parameter Access Mode	S	S;154<lf><cr> get current access mode for log hist data

Responses

	ASCII Characters	Example
Data Accepted	OK	
Error	ERROR	ERROR;82;PARAMETER SHOULD BE Y OR N<lf><cr>
System Busy	BUSY	
Valid Request Returning Scalar	@	Currently not used
Valid Request Returning Array of Scalars - Array Incomplete	P	P;154;7.1F-7;0.1F-10 <lf><cr> log hist data returned array incomplete
Valid Request Returning Array of Scalars - Array Complete	Q	Q;154;0.01F-10;0.03F-10<lf><cr> log hist data returned array complete
Valid Request Returning Structure - Structure Incomplete	,	Currently not used
Valid Request Returning Structure - Structure Complete	^	^;156;1;100;2;4;3;189;4;Y<lf><cr> returning scan preamble
Valid Request Returning Array of Structures - Structure Incomplete	b	Currently not used
Valid Request Returning Array of Structures - Structure Complete	c	Currently not used
Valid Request Returning Array of Structures - Structure and Array of Structures Complete	d	Currently not used
Valid Request Returning Parameter Access Mode	I	Currently not used

APPENDIX II

VG CP Parameter Codes

Start Multiple Ion Monitoring (MIM)	1
Start Analogue Scan	2
Start Histogram Scan	3
Start Histogram Mass Alignment	4
Start Log Histogram Scan	5
Define MIM Recipe	10
Define number of MIM cycles	80
Define Multiplexer Channel Number	81
Define MIM Pre-Lock Status	82
Define MIM Cycle Period	83
Enable/Disable Alarms in MIM	84
Define MIM Pre Zero Status	85
Alarm units	86
Define SEM Parameters	110
Define Mass Alignment Parameters	130
Define Scan Parameters	131
Set Command Page Variables	132
Acquire MIM Data	151
Acquire Analogue Scan Data	152
Acquire Histogram Scan Data	153
Acquire Log Histogram Scan Data	154
Acquire Scan Preamble	156

APPENDIX III

Serial Port options on IBM PC's and Compatibles used as a Mass Spectrometer Controller.

Two options a) 9-pin D-Shell RS232C port

b) 25-pin D-Shell RS232C port

when option a) is fitted with an optional IBM communications cable, which has a 9-pin D-Shell connector on one end and a 25-Pin D-Shell connector on the other end, the 25-Pin end of the cable has all of the signals of a standard EIA RS232C.

Pin Assignments for 9-way D-Type Connector

	Description		Pin
	Carrier Detect	1	Serial
	Receive Data	2	Adaptor
	Transmit Data	3	in mass
External	Data Terminal Ready	4	Spectrometer
Device	Signal Ground	5	
	Data Set Ready	6	
	Request To Send	7	
	Clear To Send	8	
	Ring Indicator	9	

Pin Assignment for 25 way D-Type Connector

	Description	Pin	
	NC	1	Asynchronous
	Transmitted Data	2	Communications
	Received Data1	3	Adapter
	Request to Send	4	(RS232C)
	Clear to Send	5	in mass
	Data Set Ready	6	Spectrometer
	Signal Ground	7	
	-Receive Line Signal Detector	8	
	Transmit Current Loop Data	9	
	NC	10	
	Transmit Current Loop Data	11	
External	NC	12	
Device	NC	13	
	NC	14	
	NC	15	
	NC	16	
	NC	17	
	+Receive Current Loop Data	18	
	NC	19	
	Data Terminal Ready	20	
	NC	21	
	Ring Indicator	22	
	NC	23	
	NC	24	
	-Receive Current Loop Return	25	

APPENDIX IV

Altering the RS232 presets

In order to perform this function with Micromass you will need access to an IBM PC or compatible. It must have one floppy disk drive the same as on your Micromass i.e. if you have a 5 1/4 inch floppy disk on your Micromass your PC must have a 5 1/4 inch drive. To change RS232 presets you will need to edit line 1 of the config.sys file. As supplied line 1 will read

device = com.sys 9600,n,8,1

This indicates 9600 baud, no parity, 8 data bits and 1 stop bit. Usually the best way to edit this line is to use the PC/MS DOS line editor EDLIN. For Spectralab users with hard disks EDLIN will be found in the\PCDOS directory for an IBM PC or the MSDOS subdirectory for compatibles.

Change to this directory and type

EDLIN \CONFIG.SYS

Details on how to use EDLIN are contained in the PCDOS technical manual.

Alteration of RS232 presets is best demonstrated by examples

device = comml.sys 4800,e,7,1

sets 4800 baud, even parity, 7 data bits and 1 stop bit

device = comml.sys 1200, n, 8,1

sets 1200 baud, no parity, 8 data bits and 1 stop bit

The format of the line is identical to the **mode com 1** = command under PC/MSDOS.

APPENDIX V - EXAMPLE BASIC PROGRAM LISTING

```
10 '    VG Quadrupoles Limited  Micromass Software
20 '    Remote Control Test Program - Histogram Scan Run
30 '    software written in gwbasic
40 '    responses from the micromass are displayed but are not
50 '    tested for correctness
60 '    check sums incorporated and checked, if unmatched remote exited
70 '
80 CLS
90 PRINT "REMOTE CONTROL TEST PROGRAM"
100 PRINT "HISTOGRAM SCAN RUN"
110 '
120 ' initialise RS232 port
130 OPEN "COM1:9600,N,8,1" AS #1
140 '
150 ' setup variables with dummy values for entry into input routines
160 SMASS=1000:EMASS=1000:SGAIN=0
170 DET$="-":NLINE$=CHR$(10)+CHR$(13)
180 '
190 ' input routines for histogram scan parameters
200 '
210 WHILE DET$"F" AND DET$<>"M"
220    PRINT"ENTER THE DETECTOR TYPE (F, M) ";
230    DET$=INPUT$(1):PRINT DET$
240 WEND
250 WHILE ((SGAIN OR SGAIN9) AND DET$="F") OR((SGAIN OR SGAIN13)
ANDDET$="M")
260    PRINT"ENTER THE GAIN RANGE (6-9 FOR F, 7-13 FOR M) ";
270   INPUT SGAIN
280 WEND
290 WHILE SMASS OR SMASS200
300    PRINT"ENTER THE START MASS (0-200) ";
310    INPUT SMASS
320 WEND
330 WHILE EMASS OR EMASS200
```

```
340    PRINT"ENTER THE END MASS (0-200) ";
350INPUT EMASS
360 WEND
370 '
380 ' send setup parameters for histogram scan
390 PRINT#1,"q;131;1;"+DET$+";2;"+STR$(SGAIN)+";3;"+STR$(SGAIN)+";4;"
   +STR$(SMASS)+";5;"+STR$(EMASS)+NLINE$;
400 GOSUB 740:' get response from micromass
410 '
420 ' send commands for checksum calculations
430 PRINT#1, "R;156;2"+NLINE$;
440 GOSUB 740
450 PRINT#1, "R;153;2"+NLINE$;
460 GOSUB 740
470 PRINT:PRINT"STARTING HISTOGRAM SCAN RUN"
480 '
490 ' start histogram scan run
500 PRINT#1, "O;3"+NLINE$;
510 GOSUB 740:' get response from micromass
520 GOSUB 930:' pause
530 '
540 ' get scan preamble
550 PRINT#1, "@;156"+NLINE$;
560 GOSUB 740:' get response from micromass
570 GOSUB 1110:' get checksum
580 GOSUB 930:' pause
590 '
600 ' get scan values
610 PRINT#1, "@;153"+NLINE$;
620 GOSUB 740:' get response from micromass
630 GOSUB 1110:' get checksum
640 '
650 ' test for more scan values to be read
660 IF MID$(RES$,1,1)="P" THEN GOTO 600
670 '
680 ' if X from keyboard exit remote
```

```
690 FOR I=0 TO 500:IF INKEY$="X" THEN GOTO 980:NEXT I
700 '
710 ' get next scan preamble
720 GOTO 520
730 END
740 '
750 ' read string of output from micromass
760 '
770 GOSUB 880:' read 1 character from micromass
780 RES$=ANS$
790 CHAR=ASC(ANS$)
800 ' test for carriage return for end of string
810 WHILE CHAR<>10
820     PRINT ANS$;
830     GOSUB 880:' read 1 character from micromass
840     CHAR=ASC(ANS$)
850     RES$=RES$+ANS$
860 WEND
870 RETURN
880 '
890 ' read one character from micromass
900 '
910 ANS$=INPUT$(1,#1)
920 RETURN
930 '
940 ' delay loop for RS232 control
950 '
960 FOR I=0 TO 8000:NEXT I
970 RETURN
980 '
990 ' exit remote histogram scan mode
1000 '
1010 GOSUB 930:' pause
1020 ' terminate run
1030 PRINT#1, "T"+NLINE$
1040 GOSUB 740:' get response from micromass
```

```
1050 GOSUB 930:' pause
1060 '
1070 ' exit from remote system
1080 PRINT#1, "X"+NLINE$
1090 PRINT:PRINT"EXITING REMOTE SYSTEM"
1100 END
1110 '
1120 ' calculate checksum
1130 '
1140 CHECK=0
1150 FOR I=1 TO LEN(RES$)-3
1160     CHECK=CHECK+ASC(MID$(RES$,I,1))
1170 NEXT I
1180 CHECK=(CHECK MOD 64)+64
1190 IF ASC(MID$(RES$,LEN(RES$)-2,1))<>CHECK THEN GOTO 1210
1200 RETURN
1210 '
1220 ' checksum error
1230 '
1240 PRINT:PRINT"ERROR CHECKSUMS UNMATCHED"
1250 GOTO 980
1260 END
```

19.0 WARRANTY

Products of VG Quadrupoles Limited are warranted to be free from all defects in material and workmanship. The liability of VG Quadrupoles under this guarantee is limited to servicing, adjusting or replacing defective parts. The guarantee on this basis is effective from the date of despatch to the original purchaser from 12 months provided:

1. The product is returned to the factory transportation charges prepaid and damage has not been caused by failure to provide sufficient packaging.
2. The product appears to VG Quadrupoles satisfaction to be defective through no fault of the user.
3. The guarantee only applies if the equipment is operated in accordance with the instructions and advice detailed in the appropriate operating instruction manual or any other instructions which may be provided by VG Quadrupoles Limited. Mass spectrometer filaments are not included.
4. The guarantee does not apply to components including electron multipliers which are outside the component manufacturers usual guarantee period.

Filaments are classed as consumables, and are not covered by this warranty.

Site visits can be arranged at all times in the instruments life. For equipment under warranty the purchaser must pay for engineers travelling and accommodation (if required) and forward an order number before the visit can take. For site visits outside the warranty period, contact your Service department for details.

Service contracts are available on most equipment to meet your specific requirements, please contact your local Service Department below for details.

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